THE OPENING OF THE BRAZILIAN ECONOMY AND THE STATE OF ITS FIRMS AND INDUSTRIES

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**To Martin,
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INTRODUCTION

The analysis undertaken in this study is motivated by the new economic environment faced by the Brazilian industry since the early 1990s, when major economic reforms started to be implemented. In addition to the set of price stabilization policies that the country had already been struggling with during the 1980s, the main new adopted policies intended to undertake a greater opening of the economy, its deregulation and the privatization of state enterprises.

Until the late 1980s, Brazil maintained a high level of protection of its economy. In 1980/81 the level of effective protection of manufactured goods averaged 46.4%; and in 1985 it was 42.9%. In 1988 and 1989 a rationalization of import tariffs was undertaken but the reduction of the effective levels of protection was very small. The Collor administration that began in 1990, started a new set of measures for the opening of the economy, reducing the country's mean tariff from 25.3% in 1991 to 14.2% in 1994.

These economic reforms come at a time when important changes are also occurring at the international level. There has been a greater globalization of production, major technological changes, together with an increasing share of international trade in world output. Foreign direct investments and technology flows have also been redirected as a function of investors' global production strategy, taking into account, among other factors, the conditions offered by each country in terms of technological capabilities of the labor force, degrees of protection of the economy, and the foreign capital and property rights legislation.

The greater liberalization of the economy comes after a long period of successful domestic industrialization that was induced by inward-oriented policies of import substitution. By the 1980s, however, the sources of growth from this development strategy was been exhausted. It is expected that a greater opening of the Brazilian economy, together with major structural reforms, will allow higher and sustainable rates of economic growth. This new strategy, however, needs to be coherent with industrial, science and technology policies in order to effectively attain the above objectives. The timing of the measures of trade liberalization and the incentives given for investments in new machinery and in research and development will be of crucial importance in order to define the future industrial profile of the country and its insertion in the world economy.

Due to the prospects of these major reforms, we consider important to evaluate what is the current situation of the distinct firms and industries, given their past strategies and government policies. This will allow us to better understand how a coherent set of policies towards the greater opening of the economy should be defined in order to attain the country's socio-economic objectives. Our analysis intends to contribute in identifying the ideal timing and the best set of incentives in order to allow an efficient adjustment of firms/industries into a more open and deregulated economy. This would reduce unnecessary negative impacts in domestic production and employment and would allow for the establishment of a better prepared industry ready to face greater international competition.

The issues that we consider of particular importance to be analyzed are related to the determinants of the degree of competitiveness and international insertion of firms/industries, to the current types of adjustment needed for the firms/industries in this new environment, to the process of flow of new technologies, and to whether domestic technological capabilities are required in order for firms to survive with the opening of their domestic markets.

We are concerned with identifying the existence of industry-specific as well as firm-specific determinants of performance. Industry-specific determinants are related to characteristics such as industry market structure, degree of global integration of the industry, the efficient plant and size of market required, the location of the industry in the productive structure, government's industrial and regulatory policies, among others. On the other hand, the heterogeneity of firms, even within the same industry, is in a great part determined by the distinct strategies adopted by each firm with respect to product diversification, external markets, technological strategies, ownership, etc. Those distinct strategies are what would, in the medium and long term, determine the different degrees of capability of those firms to compete in a more open economy.

The main source of data for our empirical analysis is the survey entitled Commercial Opening and Technological Strategy: The Views of Brazilian Industrial Leaders, made by the Brazilian National Industry Confederation (CNI) in 1991. This survey, which involved 699 firms, will allow us to evaluate how prepared firms and industries are to face the current policy changes and what previous circumstances made them to be so at the present time.

It is worth mentioning here there is a lack of more detailed statistical performance indicators which limits the study of the evolution of industry, and of the current state of Brazil's technological capabilities. It is under these circumstances that the methodology of analysis based on the estimation of ordered probit models, using the responses of an industrial survey that we apply in the following chapters becomes relevant since it is a practical way to obtain information that could give important insights for future actions, both at the firm and government levels. Throughout this study, the results of our model, which evaluated the Brazilian firms and industries based on a 1991 survey, will be compared with the their developments during the last four years of implementation of economic reforms.

In chapter I, we will start with a brief review of Brazil's macroeconomic performance by describing the adjustment process that took place during the early 1980s, following the three external shocks: the oil shock, the increase in the international interest rates and the external debt crisis, which, in turn, contributed to the increasing domestic disequilibria of a deteriorating fiscal account and accelerating rates of inflation. We finalize this section by discussing the potential conflicts of certain policy instruments in tackling simultaneously stabilization gosl and trade regime reforms that started to be implemented in the early 1990s. Subsequently, we will discuss Brazil'd trade performance indicators of the last 15 years, which will be followed by an analysis of the Brazilian trade regime and its opening up policy. We will end the chapter with a closer look at the main changes in the Brazilian industrial regulatory environment that accompanied trade liberalization and the performance of its industry during that period by evaluating Brazil's industrial performance during the last 18 years and some broad indicators of competitive performance of Brazil's industry during the early 1990s.

In chapter II, the survey's characteristics and the methodology to be applied in this study will be discussed: it involves the application of statistical techniques of principal components, cluster analysis and the estimation of ordered logit and probit models.

In chapter III, we will present the four dimensions of the analysis of the current state of Brazilian firms and industries facing the perspective of greater opening of the economy, their main motivation, and limitations imposed by the survey data. Following this section, we will start by testing for the presence of interindustry variations in each of the CNI-1991 survey's responses in order to verify whether one can notice industry specific characteristics.

In chapter IV, we will investigate the determinants of preparation for foreign competition. A better understanding of these determinants is fundamental in defining a coherent and, eventually, industry-specific set of policies towards a successful opening of the economy. Among these policies are included the definition of the adequate timing for trade liberalization, the establishment of an appropriate property rights regime, a science and technology policy directed to the creation of domestic technological capabilities, the development of export promotion mechanisms, and the modernization of the country's basic industrial infra-structure.

In chapter V, we will be looking at determinants of exports share in total revenue. In the Brazilian case, the opening of the economy requires the maintenance of a more stabilized economy, together with new legislation increasing foreign investment opportunities. This is necessary in order to generate a greater amount of foreign capital inflows, compensating for a larger deficit in the current account during the adjustment period of the trade liberalization program. Moreover, the government could also attempt to maintain its trade accounts somewhat balanced in terms of its increases of imports and exports, hence the importance to answer the above question in order to determine which policies could lead to an increase in the share of exports in a firm/industry's total revenue.

In chapter VI, when looking at the determinants of adjustment options with trade liberalization policy, we will try to establish the determinants of adjustment options that could be undertaken by each firm/industry in reaction to trade liberalization. These adjustments are not only an indicator of their main current deficiencies with the liberalization of the economy, but will also give a better idea of their future situation in terms of capital ownership, degree of vertical integration, diversification of production, and capital and human resources investments. This information could be helpful in determining the pace of trade liberalization and other regulatory and industrial policies that could affect the future profile of Brazil's industry.

In chapter VII, we will look at determinants of main sources of technology. This chapter attempts to contribute to a better understanding of the relationship between sources of technology and characteristics of Brazilian firms and industries, such as their market structure, degree of openness to foreign markets, location and previous exposure to foreign competition. Moreover, we shall look at the functioning of markets for technology, the recent evolution of the Brazilian science and technology program, and the relations among distinct sources of technology in the country. This could give guidelines on some relevant aspects to be considered when defining the appropriate science and technology policy and regulatory framework for the Brazilian current situation. On the one hand, with the trade liberalization that began in the early 1990s, the reduction in import restrictions of equipments is allowing for a faster modernization of the domestic industry. On the other hand, part of the domestic machinery and equipment industry might not survive with foreign competition. Moreover, the new legislation on intellectual property rights that is currently under preparation could completely change incentives for innovation as well as the mechanisms of adoption of new technologies. The long run effect of those changes in the domestic technological capabilities and competitiveness is still not very clear. In order to define a domestic technological strategy, it is important to have answers to questions such as: how does the process of flow of new technologies function, and whether or not and in which areas are domestic technological capabilities required in order to maintain a competitive domestic industry facing a greater opening of its markets. In order to have some answers to the above question, we will also discuss the specific aspects of markets for technology, in particular of technical change and diffusion, the current international techno-economic context, and the Brazilian science and technology program.

Finally, in the last chapter of this study, we will summarize our main findings and propose some general considerations that should be taken into account in the current state of the Brazilian economy, in particular with respect to trade liberalization and the required supporting regulatory framework and industrial and science and technology policies that would be appropriate to accompany it.

I - THE OPENING UP POLICY OF THE BRAZILIAN ECONOMY

In this chapter we will start with a brief review of Brazil's macroeconomic performance by describing the adjustment process that took place during the early 1980s following the three external shocks namely the oil shock, the increase of international interest rates and the external debt crisis, which, in turn, contributed to the increasing domestic disequilibria of a deteriorating fiscal account and accelerating rates of inflation. We finalize this section by discussing the potential conflicts of certain policy instruments in tackling simultaneously stabilization policies and the trade regime reforms that started to be implemented in the early 1990s. Subsequently, we will discuss some of the Brazilian trade performance indicators of the last 15 years, which will be followed by the analysis of the Brazilian trade regime and its opening up policy. We will end this chapter with a closer look at the main changes in the Brazilian industrial regulatory environment that accompanied the trade liberalization and the performance of its industry during that period.

I.1 - Macroeconomic Performance Overview of the 1980s and Early-1990s

During the last 15 years, the Brazilian economy went through serious external and domestic imbalances, that required strong adjustment measures and led, on average, to a poor overall economic performance. Gross domestic investment had fallen from an average of 23 percent of GDP during the 1970s to 20 percent in the early 1990s and, by 1994, the real *per capita* GDP was still at levels similar to 1980.[1] Inflation rates, that were at two digit levels by the end of the 1970s, reached four digit levels in 1989 and remained at these levels until 1994 when a new stabilization plan was put in place. The stabilization measures that were required during these years were also accompanied with the increasing need to implement deeper structural reforms, of which trade liberalization that started in the early 1990s, is the most prominent.

The second oil shock of 1979, together with the substantial increase in international interest rates in the early 1980s, led to a substantial deterioration in the Brazilian external balance. The tight monetary policy during this period contributed to restore the external balance by 1981. Such adjustment, which led to a recession in 1981, was mainly obtained through the inflow of voluntary capital, attracted by the high interest rate differentials, and to a lesser extent through the improvement in the trade balance.

[1] Between 1950 and 1980, *per capita* GDP grew on average by 4.5 percent a year.

Table I.1

Brazil: Economic Indicators

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Real GDP growth	10.2	-4.3	0.8	-2.9	5.4	7.8	7.5	3.5	-0.1	3.2	-4.4	0.2	-0.8	4.1	5.7
Real per capita GDP index (1980=100)	100.0	93.5	92.0	86.9	89.3	94.6	100.8	102.4	100.5	101.8	95.7	94.4	92.2	94.6	98.6
Gross fixed investment (% of GDP)	23.6	24.3	23.0	19.9	18.9	18.0	20.0	23.2	24.3	26.9	22.9	19.6	19.6	20.4	n.a.
Private 1/	21.2	21.7	20.5	18.0	16.8	15.6	16.8	19.8	20.9	23.7	19.1	16.3	15.8	16.9	n.a.
Government	2.3	2.7	2.4	2.0	2.1	2.5	3.2	3.3	3.4	3.2	3.8	3.4	3.8	3.5	n.a.
Inflation 2/	110.2	95.2	99.7	211.0	223.8	235.1	65.0	415.8	1037.6	1782.9	1476.6	480.2	1158.0	2708.6	1093.8
Public sector balance (% of GDP) 3/		-6.2	-7.3	-4.2	-2.5	-4.4	-3.6	-5.7	-4.8	-6.9	1.3	-0.2	-2.8	-1.3	0.6

1/ Includes public enterprises.
2/ General index prices (IGP-DI), annual change, end of period.
3/ Non-financial public sector operational balance.
Source: BACEN, IBGE and IADB.

With the debt crisis of mid-1982, there was a sharp decline in the access to foreign resources forcing an even stronger external adjustment. The Brazilian adjustment was remarkable with the current account balance passing from a deficit of US$16 billion (6.4 percent of GDP) in 1982 to a small surplus in 1984. Most of this switch was due to improvements in the trade balance due to the strong United States recovery of 1983-84, which increased Brazilian exports; the contractionary demand management policy adopted with the first IMF agreement in early 1983, which lead to a fall in industrial output and gross investments (6 percentage points of GDP below the levels of the beginning of the decade); and the 30 percent currency devaluation of February 1983.[2] The service account also showed some improvement mainly due to the decline in international interest rates after mid-1982. In 1984, with less restrictive demand policies and a strong increase in manufactured exports, the economy had positive growth.

[2] Bonelli, 1992.

Table I.2

Balance of Payments, 1980-1994

(US$ million)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Trade Balance	-2822.8	1202.4	780.1	6470.4	13089.5	12486.0	8304.0	11172.0	19184.0	16120.0	10753.0	10579.0	15239.0	13072.0	10390.0
Exports (fob)	20132.4	23293.0	20175.1	21899.3	27005.3	25639.0	22348.0	26224.0	33789.0	34383.0	31414.0	31620.0	35793.0	38783.0	43558.0
Imports (fob)	-22955.2	-22090.6	-19395.0	-15428.9	-13915.8	-13153.0	-14044.0	-15052.0	-14605.0	-18263.0	-20661.0	-21041.0	-20554.0	-25711.0	-33168.0
Services	-10152.0	-13135.2	-17082.5	-13415.3	-13215.2	-12877.0	-13694.0	-12678.0	-15103.0	-15331.0	-15369.0	-13542.0	-11339.0	-15362.0	-14437.0
Interest	-6311.1	-9161.0	-11353.3	-9555.4	-10202.7	-9660.0	-9327.0	-8792.0	-9832.0	-9633.0	-9748.0	-8621.0	-7253.0	-8453.0	-6397.0
Others	-16463.1	-22296.2	-28435.8	-22970.7	-23417.9	-22537.0	-23021.0	-21470.0	-24935.0	-24964.0	-25117.0	-22163.0	-18592.0	-23815.0	-20834.0
Unrequited Transfers	167.8	198.5	-8.1	107.5	170.5	150.0	86.0	70.0	94.0	244.0	834.0	1556.0	2243.0	1653.0	2596.0
CURRENT TRANSACTIONS	-12807.0	-11734.3	-16310.5	-6837.4	44.8	-241.0	-5304.0	-1436.0	4175.0	1033.0	-3782.0	-1407.0	6143.0	-637.0	-1451.0
CAPITAL	9678.7	12772.7	7850.9	2102.8	252.9	-2554.0	-7108.0	-746.0	3635.0	-3648.0	-4715.0	-4148.0	25271.0	9903.0	14836.0
Investment (net)	1532.0	2325.7	2546.9	1359.0	1548.7	1262.0	185.0	531.0	2269.0	125.0	0.0	170.0	2972.0	6179.0	8131.0
Financing and Loans	10596.0	15553.4	12515.0	6708.2	10400.8	7078.0	3109.0	2592.0	5177.0	3640.0	3424.0	2026.0	13258.0 a/	2409.0	2218.0
Amortizations Paid	-5010.3	-6241.6	-6951.6	-6862.9	-6468.2	-8491.0	-11546.0	-3105.0	-7750.0	-5889.0	-8053.0	-7830.0	-7147.0	-8982.0	-10995.0
Others	2561.0	1135.2	-259.4	898.5	-5228.4	-2403.0	1144.0	-764.0	3939.0	-1524.0	-86.0	1486.0	16188.0	10297.0	15484.0
Errors and Omissions	-343.3	-413.7	-368.4	-669.9	402.5	-405.0	56.0	-805.0	-833.0	-776.0	-328.0	876.0	-1386.0	-862.0	-446.0
Surplus (+) or Deficit (-)	-3471.6	624.7	-8828.0	-5404.5	700.2	-3200.0	-12356.0	-2987.0	6977.0	-3391.0	-8825.0	-4679.0	30028.0	8404.0	12839.0
International Reserves	5853.0	6693.0	3994.0	3972.0	11995.0	11608.0	6760.0	7458.0	9140.0	9679.0	9973.0	9406.0	23754.0	32211.0	38806.0

a/ Includes US$11,583 million of refinancing.

Sources: IBGE (1975,1980-86), BACEN (1987-94).

In addition to the economic stagnation during most of the first half of the 1980s, the Brazilian adjustment to these two external shocks, also led to the inflationary explosion and a deterioration in the government current accounts, which together with the decreased access to external financing, led to a decline in public investments from an average of 8.4% of GDP during the period 1976-80 to 5.9% of GDP during the subsequent decade.[3]

During the second half of the 1980s and early 1990s, the focus of attention moved from the external arena to the accelerating inflation, leading to several failed attempts to curb the chronic inflationary process through the imposition of price and wage freezes. The first stabilization attempt was the Cruzado Plan of February 1985, which led to a massive expansion in domestic demand increasing industrial output by almost 12 percent, putting enormous pressures in frozen prices leading to its failure. The subsequent attempts to curb inflation -the Bresser Plan of June 1987, the Summer Plan of January 1989, the Collor Plan of March 1990, and the Collor Plan 2 of February 1991- led to periods of continuous domestic disequilibria with vicious stagflationary cycles of price freezes followed by accelerating inflation, demand contraction and new price freezes.[4]

In July 1994, a new stabilization program was implemented using the combination of an emergency fiscal adjustment, the elimination of many distortions in relative prices and the adoption

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[3] Baer, 1989 and 1994.

[4] Bonelli, 1992.

of a de facto fixed exchange rate which was used as an anchor to lower inflation. Inflation was dramatically reduced and aggregate demand increased abruptly, leading to a GDP growth of 5.7 percent. The Brazilian currency appreciated by more than 20 percent in the following three months of the implementation of the Real plan which, together with the jump in domestic demand and the acceleration of the implementation of the scheduled tariff reductions for the Southern Common Market (Mercosul) treaty, led to a reduction of about US$3 billion in the country's trade surplus of 1994, mainly due to an increase in imports. It is worth mentioning, however, that most of the increase in domestic demand was supplied by an increase in domestic production of agriculture (8 percent) and industrial sectors (7.6 percent), with capital goods and consumer durables growing by 18.6 and 15.5 percent, respectively.

During the first half of 1995, the real effective exchange rate appreciated by nearly 22 percent and the economy registered a trade deficit of US$4.3 billion, the largest since 1980.[5] During this period exports grew 6.7 percent with respect to the same period of 1994, with coffee and sugar being responsible by more than two-thirds of such growth while manufactured goods remained nearly stagnant. On the imports side, the growth was of 97 percent during this period, mainly led by durable (208%) and non-durable (191%) consumer goods, followed by capital goods (91%) and raw-material (82%). Among the products that had the largest growth were

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[5] When calculating the real effective exchange rate exclusively for the industrial sector using industrial price indexes as deflators, the appreciation during the first semester of 1995 was of 6.4 percent. (IESP, 1995)

automobiles (447%), meat, vegetables and dairy products (190%), metallurgy products (135%), plastics (132%) and textiles (125%).

To conclude this section, one should mention the potential problems that can arise from the implementation of a trade liberalization policy in an economy that still faces major domestic imbalances, such as the Brazilian chronic inflation.

The Brazilian experience in the second half of the 1980s has shown that the use of the exchange rate as a nominal anchor to inflation can have perverse effects on the external trade performance. The resulting overvaluation tended to decrease the country's export competitiveness and at the same time made imports cheaper which, in a more open economy, could have lead to an unsustainable deterioration in the trade balance. Moreover, particularly in more orthodox programs, stabilization measures are accompanied by a fall in aggregate demand that, if possible, should not be added to the burdens of sectoral adjustments required by trade liberalization policies. In conclusion, as Sachs (1988) suggests, there should be a sequencing where, under a highly unstable macroeconomic environment, stabilization policies should precede trade liberalization.

Unfortunately that is not the case of the Brazilian experience in the 1990s. The more recent example is what we can see with the Real Plan, which led to a huge trade deficit mainly caused by a boom in imports. The government has attempted to counterbalance the trade balance shift by temporarily increasing certain tariffs and imposing quantitative import restrictions. However, these measures are generating uncertainties about the sustainability of the trade liberalization program. As long as there is no permanent solution to the inflationary problem, expectations of future temporary trade barriers will remain, disrupting future investments in affected industrial sectors of the country.

I.2 - Trade Performance

As described in the previous section, since the late 1970s, the Brazilian trade performance has been affected by external and domestic shocks, as well as by the ongoing set of export-oriented and import protection policies. While during most of the 1970s, Brazil had a negative trade balance, since 1981 the trade balance has shown a surplus which attained more than US$19 billion in 1988. Between 1980 and 1994, exports grew at nearly 6 percent per annum on average, against a 4.6 percent annual growth of world trade and well above the overall Brazilian economy's growth, while imports had a more modest increase of less than 3 percent per annum during the same period.

Exports:

The significant oscillations in export performance during the 1980s were due mainly to movements in domestic and external demand and in export competitiveness which was mainly affected by the variations in the real exchange rate. During the period 1991-1994, exports have enjoyed a steady increase, with an average annual growth rate of more the 11 percent.

During the 1980s, the composition of exports followed the trend observed during the previous decade of an increasing share of industrialized products, mainly to the detriment of the agriculture export share. However, while during the 1970s such an increased share was common to most exporting industries, during the 1980s growth was concentrated in relatively few of them, in particular metallurgical products, chemical products and garments, footwear and leather products. A few industries --electric material, textiles and food products-- reduced their shares in total exports.[6] During the period 1991-94, the share of industrialized products remained constant, with no significant change in their shares in total exports with the exception of metallurgical products which had their share reduced from 18.6 to 14 percent during this period.

One observes a strong inwardness of Brazil's industry, which lived under protectionist barriers on a large domestic market. The behavior of exports during the 1980s seems to have been strongly influenced by domestic cyclical variations. Econometric evidence on export equations for Brazil has shown that domestic demand was found to have an important negative effect on Brazilian exports, suggesting a clear "vent-for-surplus" logic in Brazilian exports. As Bonelli (1992) states, "this is an expected result for a country which has a large domestic market and exports a substantial proportion of scale-intensive products, and in which exports

[6] Horta, 1992.

represent a marginal activity for most exporting firms."

Imports:

During the first half of the 1980s, imports declined by more than US$9 billion, 43 percent, and by the early 1990s were still below the level of 1980, reflecting the oscillations of the Brazilian economy and the protectionist policies which were reinforced with the debt crisis of 1982. A strong recovery in imports began with the trade liberalization that started in the early 1990s with an average annual import growth of 27 percent during the period 1992-1994.

With respect to the composition of imports, the most striking changes occurred in the rise and fall of the import share of oil, due to the two oil shocks and the promotion of alcohol substitutes in the early 1980s when oil share in total imports had attained more than 50 percent, falling to the levels previous to the first oil shock of about 12 percent by 1994.

The decreasing share of imports of capital goods which occurred during the second half of the 1970s continued in the early 1980s. If we exclude oil imports, from a 43.2 percent share in 1975, imports of capital goods were reduced to only 32.7 percent of imports in 1984. Between 1985 and 1991, imports of capital goods share oscillated around 35 percent. With the import boom that began with the trade liberalization of the early 1990s, imports of capital goods began to recover faster than the other categories attaining in 1994 the same share as in 1975.

During the 1970s and 1980s, with few exceptions, the import share of consumption goods, excluding fuels, remained between 10 and 14 percent reflecting the country's high trade barriers. Between 1989 and 1991 their share jumped to around 18 percent, which is mainly explained by problems of domestic supply of food, speculative purchases due to fears of hyperinflation, exchange rate appreciation and a reduction in the number of prohibited items from over 3,000 to around 1,300. In 1994, it again attained 17 percent of non-oil imports, due to a consumption boom and an overvaluation of the currency, in particular during the second semester of the year.

In the last section of this chapter, when we discuss the industry performance, we will return to the analysis of the economy's external sector at the industry level.

I.3- Trade Regime and the Opening Up Policy

As we discussed in the first section of this chapter, in the past ten years, Brazil went through several attempts of price stabilization and, since the early 1990s, it also began important structural reforms. The entire set of stabilization and reform policies have an effect on the competitiveness of the Brazilian industry. In this section, we will focus our analysis on the factors more directly related to the trade liberalization reform which began in earnest in the 1990s. In the subsequent section we will then look at other recent reforms that are reshaping the

Brazilian economy.

As Bonelli (1992) states, until the trade reforms of the early 1990s, the Brazilian commercial regime displayed the following basic features: a highly restrictive import regime based on discretionary import licensing; a very active export promotion policy, which included subsidies and import exemptions, which were used to offset the anti-export bias created by the restrictive import regime in specific industries;[7] and real exchange rate stability against the dollar until 1979, a period of a more devalued currency up to 1987, and a trend towards appreciation thereafter.[8]

The highly restrictive import regime was mainly based on discretionary import licensing, and was used in support of industrial policies. Such restrictions were exerted at distinct protectionist levels depending upon the country's external balance position. Tariffs played only a secondary role within the Brazilian protection system. Consumer goods imports were given low priority in the issuing of import licenses, and intermediate and capital goods had to pass the additional barrier of the so-called "Law of

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[7] "In 1984, the aggregate value of all export incentives reached 48% of the FOB value of exports, 35% referring to rebates and exemptions of indirect taxes, 9.1% referring to benefits associated with draw-back operations and the rest (4.1%) produced by subsidized credit and income tax reductions." (Franco, 1993)

[8] The stable exchange rate policy of the 1970s was "a critical element in the explanation of Brazil's export diversification and growth during the 1970s, as it avoided the damaging exchange rate appreciations typical of the early post-war years." (Bonelli, 1992)

Similars".[9] Informatic goods had a special "market reserve" administered by the Special Secretariat of Informatics (SEI), who in addition to determining import restrictions, also regulated technology transfer contracts and foreign investments in the sector.[10]

However, due to tariff exemptions or reductions under "special import regimes", by 1985, nearly 67 percent of all Brazilian imports entered the country with tariff reductions or exemptions, a situation that would remain almost unchanged until 1990. The table below of the nominal and effective rates of protection in 1984 shows the consequences of the proliferation of these "special regimes" for imports during the 1980s. These regimes created a large difference between legal tariffs and the much inferior ones that were truly practiced, i.e. the "true" levels, which were calculated by the revenues of import taxes as a percentage of the value of imports. It is also important to notice that the effective rates of protection are in fact underestimated by the presence of quantitative restrictions during this period which are not taken into account in this table.

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[9] Under this "law of similars" carried out by CACEX, "any imported good should be subject to an exam to assess the extent to which one could find "similar" national products" in which case the import would be forbidden. (Franco, 1993)

[10] Franco, 1993.

Table I.3

Legal and "True" Rates of Protection, 1984

Sector	Nominal		Effective [a]	
	Legal	True	Legal	True
All manufacturing	90.0	19.1	165.6	34.5
Light manufacturing	130.5	10.1	246.1	35.2
Food	84.2	16.9	212.3	43.4
Textiles	176.9	3.3	268.4	1.1
Heavy Industry	71.9	3.9	114.4	32.4
Paper	82.2	39.4	212.9	110.9
Chemicals	34.2	11.5	95.2	24.6
Non-metallic minerals	98.7	29.5	182.1	41.5
Metallurgy	72.8	12.7	91.1	24.0
High tech	98.5	8.5	137.1	14.1
Machinery	81.2	14.9	121.3	19.1
Transport equipment	115.9	2.9	217.7	-9.6
Agriculture	57.3	22.6	63.3	26.7

a/ Is the increment in value added made possible by the tariff structure, as a proportion of the free trade value added.
Source: Bonelli (1992).

In 1988 and 1989 a rationalization of import tariffs was undertaken but the reduction of the effective levels of protection was very small.[11] The Collor administration started with a policy package called "Medida Provisória 158" of 03/15/90, which included several reductions in import tariffs and administrative controls, as well as measures affecting export promotion instruments.[12] In the document "Diretrizes Gerais para a Política Industrial e de Comércio Exterior"[13] of 06/26/90, new measures for the opening of

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11 Oliveira, 1992.

12 This "Medida Provisória 158" was later modified and transformed under the form of Law 8032/90.

13 "General Directions for Industrial Policy and Foreign Trade".

the economy were undertaken.

On the export side, income tax exemptions for export earnings were abolished as well as other subsidies and tax expenditures and the BEFIEX import-to-export program was terminated except for the contracts already in effect.[14] In the case of export taxes the only ones that still remain are a 9 percent tax on raw leather exports, and a 5 percent tax on cacao and some cacao products which was reduced from 10 percent for an indeterminate time. An Integrated System of Foreign Trade (Siscomex) was implemented and the export promotion mechanism, PROEX, was revised in 1993 with the introduction of new rules for the selection of candidates suitable for financing that intend to avoid concentration of the subsidy in one or a small number of projects.

It is, however, in the import regime that one observes the most striking changes which followed a predetermined sequencing. It started with the abolition of most "special import regimes" in March 1990. In May of the same year, the CACEX[15] list of forbidden imports, known as Anexo C, was abolished and these were substituted by high tariffs. In July, quantitative restrictions were abolished and replaced by tariffs, with the issuing of import licenses becoming an automatic procedure. Finally, in February 1991, a schedule for future tariff reductions was implemented. Under this

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[14] By the end of the 1980s, about 50 percent of manufactured exports had participated in the Befiex program, showing that "a binding element in export oriented projects was the very restrictive structure of protection in operation." (Franco, 1993)

[15] Carteira de Comércio Exterior (Foreign Trade Department, Banco do Brasil).

plan, as one can see in the table below, the country's mean tariff was scheduled to be reduced from 25.3% in 1991 to 14.2% in 1994, with the standard deviation being reduced from 17.4 to 7.9 in the same period. During the first two years, however, the larger decreases in tariffs were concentrated in intermediate and capital goods, providing a temporary shield for the domestic consumer industry in order to prepare it for greater market competition.[16]

Table I.4

Original Schedule of Brazilian Tariffs

Year	1987	1988	1989	1990	1991	1992	1993	1994
Mode	30	40	40	40	20	20	20	20
Mean	51	41	35	32.2	25.3	21.2	17.1	14.2
Standard Deviation	26	17	20	19.6	17.4	14.2	10.7	7.9

Source: Ministry of Economy (Reproduced from Oliveira, 1992, Table 11).

The methodology followed to classify the 13,500 items into seven tariff brackets was the following:[17]

(i) zero tariff: products with natural comparative advantages (mainly primary or semi-processed traditional exports), with natural protection (due to high transport costs), with no competitive domestic production and commodities with low value-added;

(ii) 5 percent rate: products which had already paid 5 percent

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[16] "Until the end of 1994 the government allowed firms using imported inputs for the production of export goods to solicit temporary reduction of their import duty, if the imported input represented a substantial cost in the production cost of the export good. This temporary zero import tariff involved about 4,500 items out of 13,000 in the Brazilian Harmonized System classification." (World Bank, 1994)

[17] From Bonelli, 1992.

in 1990;

(iii) rates between 10 percent and 15 percent: products using zero tariff products as their main input (such as paper pulp or cotton chains);

(iv) 20 percent rate: the bulk of manufactured products;

(v) 30 percent rate: fine chemicals, wheat, biscuits, pasta, TV sets, record players, video cassettes and sound equipment;

(vi) 35 percent rate: autos, trucks and motorcycles; and

(vii) 40 percent rate: computer equipment and related technology.

By 1994, the multi-year tariff reduction program was implemented with very few modifications. Already by July 1993 the mean tariff was reduced from 16.79 percent to 14.16 percent; the modal tariff remained at 20 percent; and the standard deviation was reduced from 10.79 percent to 8.26 percent. At that time, the number of tariff classifications was reduced from twelve to ten, and the maximum tariff was reduced from 55 percent to 40 percent, instead of the programmed 35 percent. In 1990 the maximum tariff rate was of 105 percent in 1990, the average rate 32.2 percent and the modal rate 40 percent. Another deviation that took place in the tariff reduction program was the increase in the tariff for oil imports from 19 percent to 38 percent, justified for revenue purposes. A frequency distribution of the tariff structure is shown below.

Table I.5

Brazil Tariff Structure

October 1992			As from July 1993		
Rate	Frequency	%	Rate	Frequency	%
0	2354	18.2	0	2455	18.9
5	154	1.2	5	114	0.9
10	1863	14.4	10	2231	17.2
15	1400	10.8	15	1321	10.2
19	1	0.0	20	6436	49.6
20	3881	30.1	25	43	0.3
25	1047	8.1	30	151	1.2
30	1525	11.8	35	138	1.1
35	221	1.7	38	1	0.0
40	438	3.4	40	25	0.2
50	6	0.0	40	25	0.2
55	25	0.2	40	25	0.2

Source: World Bank (1994).

Another important step in the process of the Brazilian trade liberalization took place with the Mercosul, a customs union with Argentina, Paraguay and Uruguay which, in January 1995, implemented a common external tariff for 8,743 items (about 85 percent of total number of items), in eleven bands ranging from zero to 20 percent. The common external tariff is of 11.1 percent with a standard deviation of 6.2. About 1,100 items, which includes capital goods, telecommunication, computer goods, will be subject to a special regime that will tend to converge overtime. By 2001 (2006 for Paraguay and Uruguay), capital goods will have a common maximum tariff of 14 percent. By 2006, informatic and telecommunication goods will have a maximum common tariff of 16 percent. Each country also has a list of up to 300 items that could have an exemption of the common external tariff until the end of the year 2000.

The intent of Mercosul is the creation of a common market not only of goods and services but also of factors of production -labor and capital-, the coordination of macroeconomic and sectoral policies and the harmonization of domestic legislation in order to improve the competitiveness of its member countries.[18] Chile and Bolivia have shown interest in joining Mercosul. This group is also having discussions with the European Union, and has shown interests in creating a South America Free Trade Agreement (SAFTA).

However, in order to maintain a sustainable course for the Real Plan, Brazil took some measures affecting the trade regime. In September 1994, the Government reduced the maximum tariff to 20 percent as a temporary measure to control domestic price rises. In April, 1995, in order to countervail the increasing trade imbalance which had already accumulated a deficit of US$4.4 billion during the previous seven months new measures were taken. Among these measures were the increase in the tariffs of 109 products, in particular cars and durable goods, to 70 percent; and the establishment of a import quota for cars which should not exceed 5 percent of domestic production. Although such changes are deemed to be temporary, they have generated uncertainty about the continuity of the integration process.

The magnitude of the trade liberalization measures in the past four years was certainly impressive. Most of the non-tariff barriers to imports have been abolished, including: discretionary foreign-exchange allocations; lists of restricted items (the negative list for informatics goods was eliminated in October

[18] IDB, 1995.

1992); and external-financing requirements for imports. The Foreign Trade Secretariat, CACEX, has been closed. One of the few non-tariff protective measure that still remains is the local content requirements for access to subsidized domestic credit by the public development bank BNDES.[19]

There still remains a considerable amount of indirect taxes that affect imports. In addition to the import duty an imported good still has to pay the following taxes or contributions: AFRMM, ATP, ATAR, ICMS, IPI, finsocial and Pis/Pasep.[20] The duty drawback mechanism may refund some of these taxes when the import is an input for the production of an export good. However, in some cases these indirect taxes may be trade distortionary as domestic produced goods are often given exemptions from indirect taxes at the state level.[21] (see table below)

[19] Banco Nacional de Desenvolvimento Econômico e Social (National Bank for Economic and Social Development -- formerly BNDE). Local content requirements were first reduced in the financing of the acquisition of domestically produced capital goods through the Special Agency for Industrial Financing (FINAME) program, and in February 1991 it was further reduced to a maximum of 60 percent from its previous level of 70 percent. Note however, that a 1988 law still in effect establishes that all firms receiving any kind of fiscal subsidy and financing from official banks and involved in government procurement are subject to local content requirements. (Bonelli, 1992 and World Bank, 1994)

[20] AFRMM is an additional to the freight cost to be used to renew the Brazilian navy. ATP is an additional of the port fee. ATAR is an additional to the airport fee. ICMS is on movements of goods and services. IPI is the tax on industrial production. Pis/Pasep and Finsocial are contributions to social security.

[21] The World Bank, 1994.

Table I.6

Indirect Duties on Trade

Taxes	Rates
ATP [a]	40 % of port rate
ATAR	50 % of port rate
AFRMM	25 % of freight cost
ICMS	0-25 %
IPI	0-15 %
Import Duty	0-40 %

a/ It was reduced to 30 percent in 1995.
Source: World Bank (1994).

I.4 - Regulatory Environment

From the Great Depression of the 1930s to the 1960s, the government had a very large presence in the economy which was justified as "necessary for achieving rapid economic development through import substitution industrialization (ISI)". (Baer, 1994) This development strategy was known as the "tripod" model of ownership structure where state enterprises were complementary to the private domestic and multinational firms. The reasons for such large participation of the state in so many distinct activities such as public utilities, banking, steel, petroleum and mining, ranged from unattractive regulations, nationalism, to lack of interest from the private sector to get involved in investments with long gestation periods.[22]

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[22] Baer (1994) describes data showing the magnitude of the state presence in the economy: In 1985, "a survey of the 8,094 largest incorporated firms revealed that state enterprises controlled 48 percent of the combined assets, 26.1 percent of sales, and 18.9 percent of employment. Finally in examining the 20 largest firms by sector, it was found that in 1990 state firms had the following percentage of sales: Public utilities-100%;steel-67%; chemicals and petrochemicals-67%;mining-60%;transport services-35%;gasoline distribution-32%;

During this period most of the new sectors where structured in an oligopolistic fashion, with foreign direct investment by multinationals benefiting from import barriers, large incentives given to successful domestic firms who were in great part vertically integrated with the multinational corporations creating industrial "enclaves", and public monopolies in sectors that required large investments.[23]

By the mid-1970s the tripod model started to lose steam as public enterprises began to compete with the private sector for scarce capital resources, both domestic and external.[24] With the external shocks of the late 1970s and early 1980s, the government shifted its priorities to the reestablishment of macroeconomic stability, at the risk of impeding the efficient modernization of the productive sectors in which it was involved. By the early 1990s, there was already a strong demand for a deeper reevaluation of the role of the state and modernization of the Brazilian economy. This has led to a significant process of liberalization, that has encompassed a larger economic role for the private sector and a greater opening of the economy.

During the 1980s, apart from the import controls and export incentives mentioned previously, the Brazilian regulatory regime also included several other features:[25]

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fertilizers-26%;and transportation equipment-21%."(p.2-3)

[23] Franco, 1993.

[24] Baer, 1994.

[25] The World Bank, 1994.

- In several sectors --in particular petrochemicals, fertilizers, steel, shipbuilding, informatics, and wheat filling-- there was a strong government control over investment.
- Fiscal incentives to approved industrial investment projects were provided through tax concessions on imported inputs, accelerated depreciation, and tax credits on purchases of locally-produced inputs. Such incentives were mostly directed to basic metal, chemical, cement, paper, and car industries.
- The government development bank, BNDES was the most important source of long-term capital.[26] The banks main loan recipients in the 1980s were in basic metals, chemicals and petrochemicals, and pulp and paper.
- With respect to intellectual property, while much of the Brazilian legislation is similar to that of other countries, there are some omissions, notably protection of pharmaceutical patents, protection of foreign trademarks not yet registered in Brazil, and the lack of a demonstrably effective protection of trade-secrets. Moreover, the INPI (Agency for Industrial Intellectual Property Rights) has pursued a restrictive policy on contracts to buy foreign technology, in particular intervening to force agreements to make the technology freely available in Brazil on expiration of the agreement. Such type of policy might have discouraged certain types of foreign investments in the country.
- There was an incipient, though modest, movement towards

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[26] By 1985, the BNDES and other government banks provided 70 percent of all loans towards investment. (Baer, 1994)

privatization of public firms during the 1980s, when less than 40 small to medium-size firms were sold for about US$720 million. Most of these firms had been previously privately owned and, due to near bankruptcy, had passed into the hand of the BNDES.

In the early 1990s, a new wave of reforms was undertaken in conjunction with the trade liberalization program. In May 1990, the Collor administration established a Federal Deregulation Program (run by an inter-ministerial commission). This program revoked 127,000 decrees written since the beginning of the Republic, and began a process of reduction of the regulatory activities of the Federal ministries, in order to facilitate the activities of the private sector. Among the main deregulatory achievements are several measures towards the simplification of economic controls and easing of entry barriers, such as: deregulating many aspects of downstream activities from oil refining (distribution and further processing), including the elimination of the single-retail-price structure covering all Brazil; liberalizing the civil air transport regime; deregulating some aspects of steel transportation; deregulating investment in fine chemicals; deregulating coal production; removing a domestic wheat-distribution monopoly; and deregulating the ports (in particular by ending a union monopoly in hiring); easing controls on broadcasting; easing controls on domestic and foreign use of credit cards.[27]

In April 1990, the Congress passed a law (Law 8.031) which established formal procedures for privatization. A Privatization

[27] The World Bank, 1994.

Committee was created and the BNDES was appointed to manage the program. Sixty four companies were put on the list for privatization, including enterprises from several activities such as steel, petrochemical, fertilizer, capital goods and transportation. By the mid-1995, 35 companies had been privatized, for a total of nearly US$9 billion, or 2 percent of GDP. Of this amount less than US$2 billion were in cash, with the remaining mainly constituted with titles of public debt. The firms involved included eight steel mills, two of the three major petrochemical plants and a large portion of their downstream plants, five fertilizer companies, and one aviation plant.[28]

The privatization process is not yet completed. Important areas that remain to be privatized are in mining, oil, telecommunications and electricity. For most of these cases, the passage of new laws is required; or constitutional amendments that would allow the privatization of certain sectors restricted to the Union (e.g. telecommunications, oil and gas), the foreign participation above the current limit of 40 percent, and the appropriate regulatory environment for these sectors. There are a series of constitutional amendments before Congress designed to open the country to foreign investment, including an end to the sectors currently reserved for Brazilian companies such as telecommunications and the oil sectors.

The deregulatory process that started in 1990 is not yet completed and its future remains uncertain, given the difficult and

[28] IESP, 1995.

sensitive political debates over its future steps. There still remains a considerable amount of government intervention in the economy through regulation and through the control of public enterprises' decisions of production, prices and new investment. It is not yet entirely clear how far should be the role of government in shaping industrial policies. Moreover, the Brazilian regulatory system has a weak institutional structure and still lacks experience on how to regulate. This situation continues to generate uncertainty that could be hindering higher levels of private investment in the Brazilian economy.

The current situation of the telecommunications sector, which is decapitalized and unable to satisfy the demand and maintain quality standards, is an example of negative consequences of past and current regulatory policies for the sector such as: inadequate rate increases, distortions within the tariff structure, interference in investment decisions and the diversion of telecommunications revenue to a general governmental fund, "market reserve", and until recently, excessive controls over imports of technologies and products, high input prices.

The use of price controls in public sector enterprises, such as the telecommunication and power industries, as an instrument to reduce inflation, has led to financial distress, impairing their ability to provide continued service. The protection of certain sectors from foreign competition has also led to higher domestic costs, reducing the incentives for domestic firms to keep up with the ever higher international standards. However, as Moreira (1995) states,

> The source of most of Brazil's problems, is not government intervention *per se* but the quality of this intervention. Deficiencies such as a weak local private sector, lack of long-term financing, low domestic technological effort, poor human capital base and limited S&T infrastructure, are not going to be solved by market forces alone. They all arise from market failures in the product (static and dynamic economies of scale) and factor markets (informational imperfections and externalities), and they call for government action. Not of the type that Brazil had in the past, but one focused on the nature of these market failures, and disciplined by the need to increase industry's competitiveness in a more open and outward-oriented economy. (p.132)

The private sector and the government should have complementary roles in developing a competitive economy. While the former should be the principal generator of goods and services in efficiently functioning markets, the government should be supplying the institutional and legal framework under which the private sector can flourish and be competitive. The establishment of a clear property rights regime, the assurance of secure contracting, and the reduction of transaction costs, should be among the government's main tasks.[29] The high inflationary environment and the succession of stabilization programs have compromised contracts through, for example, price controls and, in some cases have even led to confiscation of assets, as in the Collor Plan of 1990. The private sector has also suffered with the permanence of a complex

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[29] The World Bank, 1994a.

tax system[30] and regulatory environment, deficient public services, and high domestic interest rates.[31] These are some of the areas where the government has plenty of room for improvement.

With respect to regulatory reforms, as previously mentioned, they are unfinished and, in fact, they are a process that never ends. If, on the one hand, regulations must be stable in order to give confidence for private investments, on the other hand, they permanently have to adapt to the constantly transforming international economic environment. A stable macroeconomic environment is fundamental in order to not generate uncertainties about basic rules that could be changed for stabilization purposes as has been the case in the past years.

Among the main issues that will certainly be included in the deregulation agenda for the coming years are the following: the completion of the trade-reform; the privatization of public enterprises; the legislation on foreign-exchange transactions, foreign investment and technology transfer; and modifications in the intellectual property rights legislation.

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[30] Although the Brazilian tax burden is relatively small (24.8 % of GDP) when compare to other countries (38.9 % of GDP in the OECD countries), it should be more compatible with the tax structure of its major trade partners and competitors. (Coutinho, 1994)

[31] One of the consequences of high real interest rates and the difficulties in obtaining long term credits was the reduction in Brazilian firms leverage (total debt/total assets), which was reduced from 0.54 in 1980 to 0.31 in 1989, compared to 0.60 in Germany and Italy and 0.52 in the USA and England in the later period. Credits of the financial system to the industrial private sector fell from 11.5 percent of GDP in 1980 to 6.6 percent of GDP in mid-1993. (Coutinho, 1994)

I.5 - Industry Performance and Competitiveness Indicators

We begin evaluating the Brazilian industrial performance during the last 18 years by looking at indicators of output, employment and productivity at the industry level. Following, we will discuss some indicators of competitiveness of Brazilian industry, in particular during the early 1990s. We shall leave a more detailed analysis of the Brazilian science and technology program to be presented in chapter VII.

Before we start, however, it is worth mentioning here the lack of more detailed statistical performance indicators which limits the follow up of the industrial evolution, and a more detailed information about the current state of Brazilian technological capabilities. As Coutinho (1994) states, "the country needs urgently to have an updated information system which allows inquiries and innovations, supporting studies and allowing comparisons of Brazilian results with its main international competitors."(p.11) It is under these circumstances that the methodology of analysis based on an industry survey that we apply in the following chapters becomes even more relevant since it is an uncomplicated way to obtain important information and could give important insights for future actions both at firms and government levels.

Industry Performance:

For the purpose of the analysis of output, employment and productivity indicators, we divided the years 1976-94 into four sub-periods: 1976-80, when there were still important investments under the second National Development Plan (II PND); 1981-85, characterized by the effects of external shocks in oil prices, interest rates, and debt crisis; 1986-90, a period of failed stabilization plans; and 1991-94, when the process of deregulation, privatization and liberalization of the trade regime began.

The industrial output indicator clearly shows from a steady growth of more than 6% per year during the period 1976-80, industry remained stagnant during the "lost decade" of the 1980s and began to recover only in the early 1990s at an average annual rate of 2.4 percent. In fact, such recovery in this last period was mainly concentrated in the last two years with growth rates above 7 percent. By 1994, industrial output was about 40 percent greater than in 1976.

Table I.7

Industrial Productivity, Output and Employment

(average annual percent growth)

	Industrial Productivity				Industrial Output				Industrial Employment			
	1976-80	1981-85	1986-90	1991-94	1976-80	1981-85	1986-90	1991-94	1976-80	1981-85	1986-90	1991-94
Industry General	3.6	5.1	-0.4	8.7	6.1	-0.2	0.3	2.4	2.4	-5.1	0.8	-5.8
Mining	4.3	10.7	10.5	13.6	7.0	14.1	2.0	1.3	2.6	-6.6	-7.6	-10.9
Nonmetallic mineral prod.	4.3	3.4	-1.0	7.0	6.6	-2.5	1.2	0.1	2.2	-4.7	2.3	-6.5
Metal products	4.4	3.7	-1.3	8.2	8.2	-1.0	0.0	4.3	3.6	-3.3	1.3	-3.6
Machinery	1.6	1.2	0.0	8.9	3.9	-5.2	0.2	3.4	2.2	-6.4	0.2	-5.0
Elec. and communic. equip.	4.3	6.8	1.2	11.1	9.1	1.5	2.8	1.9	4.6	-6.1	1.5	-8.2
Transport Equipment	1.4	-0.5	-4.6	12.6	5.2	-6.1	-2.1	8.4	3.8	-1.0	2.6	-2.9
Paper products	4.0	6.6	0.2	10.0	9.4	5.2	2.2	3.1	5.2	-1.5	2.1	-6.3
Rubber products	5.5	1.2	-0.7	10.5	5.5	1.8	2.4	3.9	0.0	1.3	3.1	-6.0
Chemicals	4.9	5.9	-0.3	11.8	6.7	2.9	-0.9	3.5	1.7	-2.6	-0.6	-7.5
Pharmaceutical	0.8	6.8	-2.0	0.8	0.1	2.1	0.4	-0.7	-0.8	-2.5	2.4	-1.5
Perfumes, soaps and candles	4.7	8.6	1.0	6.6	7.8	9.7	5.5	3.2	3.0	0.0	4.5	-3.2
Plastic products	3.9	0.7	-3.8	5.8	7.5	-1.6	0.4	0.2	3.5	1.5	4.3	-5.2
Textiles	5.3	2.9	-4.1	7.7	5.8	-3.2	-0.9	-1.4	0.5	-2.0	3.2	-8.3
Clothing and footwear	2.6	0.1	-1.1	1.9	5.5	-5.1	-4.5	-5.4	2.8	-4.2	-3.5	-7.2
Food products	1.5	1.7	-0.6	6.9	3.2	3.0	1.6	1.2	1.7	1.8	2.1	-5.3
Beverages	2.5	3.8	3.6	9.3	6.6	6.2	7.4	1.5	4.1	-1.3	3.7	-7.1
Tobacco products	5.1	8.2	5.5	5.0	4.7	6.9	2.9	-2.2	-0.2	-6.5	-2.4	-7.0

Source: IBGE, IPEA, BNDES and own calculations.

At an industry level output performance tended to follow the aggregate trend during each of these four periods. There were, however, some exceptions: some industries experienced significant positive growth during the 1980s, such as mining, perfume, soaps and candles, beverages and paper products; and, some others, clothing and footwear, textiles and pharmaceutical, showed a negative growth in the early 1990s.

With respect to the level of employment, measured by the number of hours worked, during the first three periods it tended to follow the output cycles both at aggregate and industry levels. This, however, did not occur in the early 1990s when employment at the industrial sector fell by an annual average of nearly 6 percent. During this period, some industries showed decreases in employment that were above 8 percent, such as mining, textiles and electrical and communications equipment. Overall, by 1994, industrial employment was about 30 percent below the level of 1976.

One interesting aspect that is worth mentioning here is the fact that the reduction in employment as measured here by the number of hours worked oscillates more than movements in the number of workers employed. This shows that, with changes in the level of activity, firms prefer to adjust the number of hours per worker before beginning adjustments in the size of their labor force.

Our third indicator of industrial performance to be analyzed is average annual productivity growth. This indicator is the ratio of the two previous industrial series, industrial output and employment. This is obviously only a partial indicator of industrial productivity since changes in other factors of production, in particular associated with new capital investments and inputs, are not being taken into account.[32]

During the period 1976-80, industry productivity grew at an annual average rate of 3.6 percent that was mainly explained by industrial output growth which increased two to three times faster than the employment level. In the early 1980s, the productivity growth of 5 percent per year was almost solely explained by a fall in employment of the same magnitude while output remained stagnant. In the second half of the 1980s productivity growth was slightly negative (-0.4 percent) with negligible increases in both industrial output and employment. Finally, during the early 1990s, productivity increased by an annual average of 8.7 percent, with about two-thirds due to a fall in employment and the remaining due to an increase in industrial output. By 1994, industrial productivity was double the level of 1976.

Such great performance in this last period, which combined increasing outputs and firms' managerial reorganizations, is in great part a response to the major liberalization reforms that were taking place, that required important productivity improvements in order to face a more competitive market environment. In fact, during 1991 and 1992 productivity improvements were less

[32] With respect to new capital investments, as previously mentioned, gross investments fell from an average of 23 percent of GDP in the 1970s, to 20 percent of GDP during the early 1990s, which does not suggest any significant movement towards a greater modernization. However, a more interesting indicator is the behavior of imports of capital and intermediate goods which increased by 112 and 65 percent, respectively, between 1990 and 1994, showing the effects of the trade liberalization and possibly indicating the effort of domestic firms to the acquisition of new capital and input vintages.

significant and mainly due to layoffs in a period of a stagnant domestic economy. It is during 1993 and 1994, when the reforms have already advanced significantly and the Brazilian economy began to recover, that we see the capacity of supply response of an industrial sector in the process of modernization. During these two years productivity grew by more than 10 percent per year, with output increases being responsible for about three quarters of the improvement.

In analyzing the productivity indicator, again we can see some exceptions at the industry level. The mining sector tended to have an above average performance during the entire period, with output almost tripling while employment was halved. The machinery and the transportation industries had a very slow increase in productivity until 1992 when, facing greater competition from imports, they started a fast recovery of nearly 20 and 14 percent per year, respectively, nearly entirely explained by increases in output. Finally, the pharmaceutical industry, with the exception of the first half of the 1980s, had no improvements in productivity during this entire period. Such behavior, in particular during the early 1990s, is in good part explained by the still undefined property rights legislation that continues to provide a considerable amount of protection to domestic producers.

Competitiveness Indicators:

We now turn to the analysis of some indicators of competitiveness of the Brazilian industry for the period 1990-1994.

We start by looking at the growth performance of exports and imports between 1993 and 1990 and the respective share of each industry for the later period.[33]

The total exports of manufactured goods attained US$37.8 billion in 1994 (US$33.7 billion in 1993), representing an impressive growth of 41 percent with respect to 1990 (26 percent if compared with 1993). Among the industries with the great export expansion during this period, we should highlight machinery (71 percent) and transport equipment (44.6 percent) due to their important shares in total manufacturing exports (7.2 and 12.8 percent, respectively). On the other hand, industry exports from metal products, and chemicals industries, which together represented one third of manufacturing exports, experienced below average growth (22 and 29 percent respectively). Some industries with small shares in total exports -- wood products; furniture; perfumes, soaps and candles; plastic products; and beverages -- have more than doubled their exports during this period. Finally, it is worth to mention the modest performance of the textile industry (9.7 percent).[34]

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[33] For exports, we were also able to include the growth rate for the period 1990-94.

[34] The textile industry has been undergoing a process of rationalization: there are now some 3,500 textiles manufacturers, around 800 fewer than in 1990; and the number of employees has been reduced from 730,000 to 375,000 in the same period. However, output has not fallen significantly. The industry has invested heavily in the last few years. Between 1989 and 1994, US$2 billion was spent on improving modern machinery. Mills operated at around 85 percent capacity during 1994, when demand only began to grow in the second half of the Real Plan, and have been operating at close to 90 percent capacity so far this year. Financial results suggest that the industry is currently obtaining a 30% return on capital.

Table I.8

Exports and Imports Growth and Shares by Type of Industry

(percent change)

	Growth			Share	
	Exports 1993/90	Imports 1993/90	Exports[a] 1994/90	Exports 1993	Imports 1993
Manufacturing Industry	26.0	46.6	41.2	100.0	100.0
Nonmetallic mineral prod.	78.6	16.1	76.2	1.3	0.8
Metal prod.	18.5	7.6	22.0	19.1	4.9
Machinery	53.2	22.2	71.0	7.2	14.4
Electrical and communications equip.	31.7	27.5	35.6	4.3	13.8
Transp. Equip.	32.4	126.4	44.6	12.5	12.8
Wood products	95.3	-5.1	144.3	2.5	0.2
Furniture	502.5	107.5	565.9	0.7	0.2
Paper products	24.9	8.8	47.6	4.4	1.4
Rubber products	80.8	28.2	94.4	1.5	1.2
Leather products	38.1	7.4	58.9	1.2	0.9
Chemicals	7.9	74.8	29.0	15.1	28.6
Pharmaceutical	56.1	57.2	65.0	0.3	2.1
Perfumes, soaps and candles	202.6	74.2	223.2	0.3	0.3
Plastic products	210.2	179.8	224.5	0.3	0.4
Textiles	7.1	179.8	9.7	3.1	4.4
Clothing and footwear	61.1	9.3	38.5	6.2	0.4
Food products	4.9	25.2	39.4	14.6	7.4
Beverages	76.4	-4.9	165.4	0.3	0.7
Tobacco products	48.1	1216.7	69.9	2.6	0.1
Printing and publishing	210.7	-2.8	54.7	0.3	0.4
Others	53.4	21.6	67.0	2.0	4.6

a/ Data for imports at industry level was not available for 1994.
Source: BNDES.

During the period 1990-93 manufacturing imports have grown even faster than exports (46.6 against 26.0 percent), with most of it taking place in 1993.[35] Due to their overall impact in total manufacturing import growth, it is worth stressing the expansion of imports in the transport equipment (126 percent), textiles (180 percent) and chemicals (75 percent) industries. The latter was responsible for nearly 30 percent of imports.

Another interesting indicator of the performance of the Brazilian industry in the early 1990s is the so called "revealed industry competitiveness indicator" (RICI). This indicator measures

[35] Overall trade data for 1994 shows that imports grew 30 percent against an export growth of 34.9 percent (12 percent in manufacturing goods). Manufacturing goods represent about three quarters of total imports and 85 percent of total exports.

the proportion of domestic consumption that is supplied by domestic production, taking into account the external transactions. RICI is measured by

$$Q/D= 1+X/D-M/D,$$

where Q-production, D-domestic demand, X-exports, and M-imports. If RICI >(<)1, the country shows competitive advantage (disadvantage) in industry.[36] This indicator reveals how distinct industries reacted to the major structural reforms that were undertaken during the period.

Table I.9

Revealed Industry Competitiveness Indicator a/

	1990	1991	1992	1993
Total manufacturing industry	1.04	1.05	1.08	1.05
Nonmetallic mineral prod.	1.01	1.02	1.02	1.04
Metal prod.	1.15	1.20	1.24	1.21
Machinery	0.96	0.95	0.97	0.97
Electrical and communications equip.	0.93	0.92	0.92	0.88
Transp. Equip.	1.09	1.09	1.17	1.06
Wood products	1.02	1.03	1.04	1.05
Furniture	1.00	1.01	1.02	1.03
Paper products	1.07	1.08	1.12	1.11
Rubber products	1.03	1.06	1.12	1.12
Leather products	1.08	1.15	1.33	1.21
Chemicals	1.03	1.00	1.01	0.97
Pharmaceutical	0.92	0.88	0.93	0.92
Perfumes, soaps and candles	1.00	1.00	1.01	1.01
Plastic products	1.00	1.00	1.01	1.00
Textiles	1.05	1.09	1.09	1.01
Clothing and footwear	1.12	1.22	1.35	1.37
Food products	1.09	1.09	1.11	1.10
Beverages	0.97	0.97	0.97	0.98
Tobacco products	1.37	1.55	1.64	1.50
Printing and publishing	0.99	0.99	0.99	1.00
Others	0.94	0.93	0.93	0.93

a/ Measured by Q/D= 1+X/D-M/D, where Q-production, D-domestic demand, X-exports, and M-imports.
Source: BNDES.

Between 1990 and 1993 about half of the industries have shown

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[36] In the long run, no matter the degree of openness of the economy, this indicator for the total of exports and imports should tend to one. However, we could still find significant differences from one for the manufacturing sector as a whole and, in particular at the industry level, revealing the country's degree of competitiveness in each of them.

some improvement in the RICI, and about one third remained at about the same levels. The industries that have shown some decline in this competitiveness indicator were electrical and communications equipment, transportation equipment, chemicals, and textiles. By 1993 there were five industries with RICI below one, namely machinery, electrical and communications equipment, chemicals, pharmaceuticals and beverages, which could be an indicator of a lesser degree of competitiveness in these industries.

In an extensive study about Brazil's industrial competitiveness that took place in 1992, Coutinho and Ferraz (1994) classified industries in three major groups (see table below): industries with competitiveness, industries with deficient competitiveness, and industries responsible for technology innovation diffusion. This last group was also considered to be lacking competitiveness. Although this classification of industries is somewhat distinct from the previous table of Revealed Industry Competitiveness Indicator, it shows some similar patterns, and allow us to see some specificities within, what the authors denominate an industrial complex. For example, in the case of the agroindustrial complex, while soy oil, coffee and orange juice are classified as competitive, firms dealing with animal slaughter and milk products are not.

Industries with competitiveness capabilities possess high productive efficiency and export performance, and benefit from a broad base of mineral, agricultural, forestal and power resources available in the country. They generally own good capacity of process management, adequate technical scales of production, and updated equipment. However, the main products of these industries are commodities with low value added, facing excess supply and stagnating international markets.

Table I.10

Industrial Competitiveness Classification

Industries with Competitiveness	
Agroindustry Complex	soy oil; coffee, orange juice
Chemical Complex	petroleum; petrochemicals
Metalmechanics Complex	iron ore; siderurgy; aluminum
Cellulose and Paper Complex	cellulose; paper
Industries with Deficient Competitiveness	
Agroindustry Complex	cattle slaughter; milk products
Chemical Complex	fertilizers
Metalmechanics Complex	automobiles; auto parts
Electronics Complex	consumption electronic goods
Textile Complex	textiles; clothing; leather shoes
Construction Materials Complex	cement; ceramics; plastics for construction
Cellulose and Paper Complex	graphic arts
Others	wood furniture
Industries Responsible for Technology Innovation Diffusion	
Electronic Complex	informatics; telecommunications; industrial automation; software
Metalmechanics Complex	machinery tools; electrical power equipment; agriculture machines
Chemical Complex	pharmaceuticals; agriculture pesticides
Others	biotechnology

Source: Coutinho, 1994.

Industries with deficient competitive capabilities are mainly directed to the domestic market which has a great potential by has suffered a considerable contraction between 1989 and 1992, inhibiting new investments, leading to outdated equipments and high levels of idle industrial capacity. These industries are responsible for the majority of the county's industrial production and employment. There is, however, some very competitive firms within these industries, such as in poultry slaughter, textiles, leather shoes, ceramics, plastics for construction and autoparts.

The third group, industries responsible for technology innovation diffusion, are also among the ones lacking competitiveness, and were the most affected by Brazil's economic instability, in particular producers of capital goods, due to the contraction of private and public investments and the increasing difficulties in obtaining long term financing. Although in several segments of these industries we can find a satisfactory productive capacity and availability of human resources, there is a serious lack of articulation in the productive chain with the suppliers of parts and components (in special in microelectronics), and with clients, which is fundamental for the development of appropriate products. There is also, particularly in the electromechanic products, a lack of specialization which led to a dispersion of efforts and an excessive vertical integration of production.[37]

The share of exports in total production is also a good indicator of the export orientation of an industry. It is true that, as already mentioned in the trade performance section, we have observed a "vent-for-surplus" logic in Brazilian exports. Such behavior explains in great part the increased share of exports in total production from 9.2 percent in 1990 to 14 percent in 1992, a period during which GDP contracted by about 5 percent. However, although during the following two years the economic recovery was quite significant (GDP growth of 4.1 and 5.7 percent, respectively), the share of exports in total production have only fallen slightly from their peak in 1992, remaining well above the 1990 level. In addition to the increasing domestic demand, the

[37] Coutinho, 1994.

effects of the appreciation of the real effective exchange rate of 11 and 14 percent in 1993 and 1994, respectively, might also have increased firms' financial incentives to sell in the domestic market. This recent export performance of Brazil's industry can be a sign of a distinct market strategy as well as increased competitiveness.

The industries with the greatest increase in export share between 1990 and 1994 were leather products, rubber products, clothing and footwear, while pharmaceuticals and printing and publishing have shown negligible increases. By 1994, the industries that would be considered "typically exporters" (export shares greater than 25 percent) were only leather products and tobacco products industries.

Table I.11

Share of Exports in Total Production
(in percent)

	1990	1991	1992	1993	1994
Manufacturing Industry	9.2	11.5	14.0	13.5	13.2
Nonmetallic mineral prod.	3.0	3.8	4.7	6.1	5.3
Metal prod.	15.6	20.1	22.3	20.5	18.5
Machinery	6.8	9.7	11.1	12.2	10.3
Electrical and communications equip.	6.2	8.6	12.5	12.3	9.9
Transp. Equip.	13.1	15.8	24.1	17.3	18.0
Wood products	2.1	3.0	3.7	4.6	5.0
Furniture	0.5	1.1	2.5	3.7	3.0
Paper products	9.0	9.7	13.2	12.9	16.3
Rubber products	8.2	14.2	19.2	21.4	18.7
Leather products	21.1	32.6	41.6	33.9	39.2
Chemicals	12.5	12.4	13.9	14.0	15.0
Pharmaceutical	2.0	3.4	3.2	2.8	2.5
Perfumes, soaps and candles	0.9	1.5	2.2	3.4	2.81
Plastic products	0.6	1.0	2.2	2.5	2.5
Textiles	7.4	10.5	12.5	10.4	10.2
Clothing and footwear	11.4	19.0	26.5	27.9	21.2
Food products	11.2	12.6	13.6	13.9	16.5
Beverages	1.4	1.9	2.3	2.6	3.7
Tobacco products	27.5	36.6	40.2	34.1	34.8
Printing and publishing	0.5	0.5	1.0	2.1	0.7
Others	7.4	10.6	13.8	15.8	15.3

Source: BNDES.

We now turn to the last two indicators of competitiveness to be discussed in this section, namely the unit labor cost and the industry implicit deflator. The unit labor cost (ULC) consists of the average wage expressed in U.S. dollars, adjusted for productivity change. The industry implicit deflators (IID) is the ratio between the index of each industry price deflator (industry production divided by its physical production) and the total manufacturing price deflator.

The unit labor cost in the manufacturing industry fell 7.6 percent between 1990 and 1994 indicating an increase in the potential competitiveness of the Brazilian industry. This was mainly due to increases in productivity which allowed for a small increase in the average real wages during this period.[38] The sectors with greater reductions in the unit labor costs were plastics products (-16.3%), transport equipment (-13.2%), and metal production (-13.1%), while pharmaceuticals (38.6%), clothing and footwear (1.0%), and perfumes, soaps and candles (0.7%) industries have registered increases in the unit labor cost between 1990 and 1994.

[38] Corrêa, 1995.

Table I.12

Unit Labor Costs and Industry Implicit Deflators, 1990-94

	Unit Labor Cost[a]	Industry Deflator[b]
Total manufacturing industry	-7.6	100.0
Nonmetallic mineral prod.	-0.8	107.9
Metal prod.	-13.1	101.0
Machinery	-8.7	107.5
Electrical and communications equip.	-10.6	84.7
Transp. Equip.	-13.2	87.7
Paper products	-9.5	80.0
Rubber products	-11.7	84.9
Chemicals	-2.5	115.3
Pharmaceutical	38.6	159.9
Perfumes, soaps and candles	0.7	99.3
Plastic products	-16.3	89.9
Textiles	-11.8	87.0
Clothing and footwear	1.0	96.2
Food products	-7.2	98.7
Beverages	-10.3	93.6
Tobacco products	-7.3	131.7

a/ Percent change between 1990 and 1994.
b/ Base is the average price change of the entire industry between 1990 and 1994.
Source: BNDES.

Finally, the industry implicit deflator can be an indicator of the relative efficiency of industrial sectors. Overtime, prices should converge to the overall industry average, and deviations that can not be explained by seasonal factors could be attributed to non competitive market structures, that allow the practice of prices systematically above the manufacturing average.[39] The industries that have shown price increases significantly above the average are pharmaceutical (59.9%), tobacco products (31.7%), chemicals (15.3%).

We shall now turn in chapter II to the presentation of the data and the methodology of analysis to be employed in our assessment of the opening of the Brazilian economy and the state of its firms and industries.

[39] Corrêa, 1995.

II - SOURCE OF DATA AND METHODOLOGY OF ANALYSIS

II.1 - Source of Data and Survey's Characteristics

The main intent of the survey Commercial Opening and Technological Strategy: The Views of Brazilian Industrial Leaders (CNI, 1991) was to evaluate the entrepreneurial perceptions with respect to the velocity of the tariffs reductions announced on February 6 1991 and scheduled to be undertaken between 1991 and 1994, their impact on decisions of investments, adjustment options, obstacles to modernization, main sources of technology, and some related topics. The publication of CNI summarizes the results of the survey at the industry level. The Economics Department of CNI was very kind to allow me access to their data bank with the survey responses at the firm level.

This survey involved the participation of 699 entrepreneurial leaders, who were consulted through a questionnaire which was sent on February 14 and returned by March 15, 1991. At that time, Brazil's economy was performing weakly. In the first quarter of 1991, the level of industrial production was 7.8% below the one in the previous quarter and 20.2% below the first quarter of 1990. This fact could have partially influenced some of the survey results.

II.1.1 - Characteristics of Firms Surveyed

Given the method of selection of the entrepreneurial leaders, the firms involved were mainly of large and medium size. Those firms, at the time of the survey, employed more than 1 million workers. Their total revenue in 1989, was over 57% of the industrial GDP[1].

The industry distribution of firms participating in the survey is close to the share of each industry in the total value of manufacturing (TVM). The table below shows the distribution of surveyed firms per industry and the industry's share of the value of manufacturing in the Brazilian economy. The industry classification basically corresponds to two-digit lines of business defined by the Brazilian Institute of Geography and Statistics (IBGE).

[1] This number could be overestimating their real share on the industrial GDP since, in the total value of revenues, there exists some double counting.

Table II.1

Distribution of Surveyed Firms per Industry and Industry's Share of the Value of Manufacturing (TVM)

#	Industry	Survey (%)	TVM (%)
01	Mining	1.8	8.8
02	Nonmetallic mineral products	3.7	3.9
03	Metal Products	15.6	11.1
04	Machinery	9.9	8.4
05	Electrical and communications equip.	8.0	6.9
06	Transportation equipment	5.9	5.9
07	Wood products	2.4	2.7
08	Paper products	3.7	2.7
09	Rubber products	1.8	1.7
10	Leather products	1.4	0.6
11	Chemicals	14.1	15.8
12	Pharmaceutical and veterinary	2.1	1.6
13	Perfumes, soaps and candles	1.2	0.8
14	Plastic products	3.0	2.0
15	Textiles	7.9	5.4
16	Clothing and footwear	4.0	4.7
17	Food products	11.7	11.0
18	Beverages	0.6	1.1
19	Tobacco products	0.2	0.7
20	Printing and publishing	1.4	1.8
	Miscellaneous industry	-	2.4

Source: CNI, 1991.

The share of exports on these firms' total income had the following distribution:

Table II.2

Share of Exports on Total Income of Surveyed Firms (%)

Range	%
0 to 5%	53.1
6 to 10%	15.1
11 to 15%	9.0
16 to 30%	13.1
More than 30%	9.7

Although it was not possible to obtain information on the origins of capital at the firm level, the survey estimates the following global distribution for the participating firms:

Table II.3

Origin of Capital of Surveyed Firms (%) [a]

Domestic	68.0%
Foreign	14.6%
Public	3.6%
Unknown	13.6%

a/ Based on the control of the majority of shares.

II.1.2 - Questionnaire Design

Part of the responses are firm specific, such as IBGE's two- and four-digit industry classification, share of exports in total revenue, number of employees, total revenue, and the State where the firm is located. But, the majority of questions were formulated in such a way that each respondent should report the general experience or central tendencies within a particular industry. It treated respondents as informed observers, protecting them from divulging their own firms' situation and strategies. ANNEX 1 gives the list of the fifty-five questions included in the questionnaire.

The answers for each of the industry questions were based on a one to six scale indicating an increasing degree of intensity. The methodology applied to analyze the data is discussed below.

II.2 - Methodology of the Analysis

The steps of the analysis of the survey results will be the following:

1 - In chapter III:

- i. To state the four basic dimensions of the opening of the Brazilian economy to be analyzed in this study and their initial set of explanatory variables.
- ii. To test for the presence of significant variance between industries at the two and four digits of IBGE classification for all the survey responses.

2 - In chapters IV to VII, the following substeps will then be made for each dimension of the economic problem to be analyzed:

i. To define the initial hypothesis on the explanatory variables.

ii. To use principal components analysis to combine, whenever possible, correlated explanatory variables in order to specify the ordered probit models. Correlation analysis will also be used for a preliminary check of the initial hypothesis.

iii. To apply cluster analysis to define groups of industries with similar patterns that could be analyzed as separate subsamples of the survey's data.

iv. To estimate the models at the firm level for the entire sample and for some specific industries or group of industries as defined by the cluster analysis.

v. To analyze the main results.

vi. To sum up and compare the main results with the Brazilian economic experience described in chapter I.

The main conclusions of this study will then be summarized in the last chapter. Before applying these steps to analyze the survey the above mentioned statistical techniques will be described.

II.2.1- Analysis of Variance

When analyzing the survey questions, we would like to identify not only differences at the firm level but also at the industry level. The analysis of variance technique is undertaken in order to check the presence of interindustry variation in the responses of the questionnaire. If the variability around each industry is small compared with the variability among the industries, this would mean that industry level variations are significant.

Among the procedures for testing the equality of industry means we adopted the one-way analysis of variance. Hypothesis test for the one-way analysis of variance is made as follows.[2]

Based on independent random samples of n_1, n_2, ... , n_k, from K populations, one gets a sample with $n = n_1 + n_2 + \ldots + n_k$ observations. In this study, K represents the number of industries and n_i is the number of firms in industry i. It is assumed that the population variances are equal and that the population distributions are normal. The null hypothesis to be tested is that the K population means are equal, that is,

$$H_0: \mu_1 = \mu_2 = \ldots = \mu_k$$

A test of significance level α is provided by the decision rule

$$\text{Reject } H_0 \text{ if } \quad \frac{MSG}{MSW} > F_{K-1,n-K,\alpha}$$

MSW is the within-groups mean square, i.e., an unbiased estimate of the population variance calculated by the sum of the

[2] The hypothesis tests for one-way analysis of variance are based on Newbold (1991). The statistical package used for the analysis of variance was Statgraphics (1989) by STSC, Inc.

variability around the individual industry means of the K industries divided by (n - K). MSW is calculated by

$$\mathrm{MSW} = \frac{\sum_{i=1}^{K} \sum_{j=1}^{ni} (x_{ij} - \bar{x})^2}{n - K}.$$

MSG is the between-groups mean square. If the industry means are equal, MSG is also an unbiased estimate of the population variance calculated by the variability among the K industry means divided by (K - 1). MSG is calculated by

$$\mathrm{MSG} = \frac{\sum_{i=1}^{K} n_i \, (\bar{x}_i - \bar{x})^2}{K - 1}, \text{ and}$$

If the industry means are not equal, MSG will not be an unbiased estimate of the population variance and its value will be greater than MSW. Whenever the ratio MSG/MSW is large, one would reject the null hypothesis that the K industry meas are equal. The random variable corresponding to the ratio of mean squares follows the F distribution with numerator degrees of freedom (K-1) and denominator degrees of freedom (n-K).

II.2.2- Multivariate Procedures

Since in many cases, the number of responses for a single question exceeded the desirable number of explanatory variables to be estimated in the final model, we employed a multivariate procedure, the principal components analysis, in order to reduce the dimension of possible responses. For example, in the question about the adjustment options that would be more frequent in an industry with the trade liberalization policy, there were thirteen types of adjustment included in the questionnaire (see ANNEX 1). Principal components analysis will be used to combine correlated explanatory variables in order to specify the final ordered probit model to be estimated.

Another multivariate procedure, the cluster analysis, will be employed to verify the existence of similar patterns among the industries. It will allow us to reduce the number of industries' strata in order to estimate the model for each selected set of similar industries. It will also allow us to verify whether the significance of the explanatory variables varies among each strata. This procedure is also important because of the fact that due to the small sample size of some industries, it is not possible to estimate the model for all industries individually. By using cluster analysis, however, one can aggregate these industries in a consistent manner in order to undertake these estimations.

The statistical package that we used for the multivariate procedures was Statgraphics (1989) by STSC, Inc. The description of the two multivariate procedures follows below.

i- Principal components analysis

Principal components analysis reduces the number of variables in a data set by finding linear combinations of those variables that explain most of the variability. This procedure works as follows.[3] Let's suppose that one has k explanatory variables. After standardizing all variables to unit variances, one can calculate linear functions of these variables such that

$$z_1 = a_1 x_1 + a_2 x_2 + \dots + a_k x_k$$
$$z_2 = b_1 x_1 + b_2 x_2 + \dots + b_k x_k \quad \text{etc.}$$

Then, one chooses the a's so that the variance of z's is maximized, subject to the condition that the sum of squares of the coefficients of the x's is equal to 1, i.e., the normalization condition, such that

$$(a_1)^2 + (a_2)^2 + \dots + (a_k)^2 = 1$$

This process of maximizing the variance of the linear function z subject to the normalization condition produces k solutions. For each solution one constructs a linear function $z_1, z_2, \dots, z_k$, that are the principal components of the x's. One can then order the principal components such that

$$\text{var}(z_1) > \text{var}(z_2) > \dots > \text{var}(z_k)$$

z_1 is then called the first principal component, z_2 the second principal component, and so forth.

A property of the principal components is that

$$\text{var}(z_1) + \text{var}(z_2) + \dots + \text{var}(z_k) = \text{var}(x_1) + \text{var}(x_2) + \dots + \text{var}(x_k).$$

[3] This description of principal components analysis follows Maddala (1988).

The direct linear combinations of the z's with the dependent variable does not necessarily have an economic meaning. One needs to analyze the coefficients of the original explanatory variables (the a's, b's,etc.) in each of the principal components. If we can find an economic interpretation of those coefficients this will allow us to combine the explanatory variables in a more insightful and reduced manner.

In the two tables below, one can see the results of principal components analysis in the case of the five possible sources of technology. In the first table, the proportion of the total variance accounted for each component is tabulated. Here, for example, the first principal component is responsible for 39 percent of the total variation and the second is responsible for 20 percent. In the second table one can see the coefficients of the original explanatory variables in the first three principal components that together are responsible for more that three quarters of the total variability. In the first component, all coefficient signs are positive, indicating that all sources of technology contribute in the same direction to the variations of the principal component. However, own firm's technology (OF) and foreign technology (FT) have coefficients with about half of the weight of the other three sources. This is an indicator that one could divide these variables into two main groups: OF and FT as the first group; and SB, UR and EF as the second. The second principal component confirms this division. Here, the two groups of variables' weights are exactly the opposite, and two variables of the second group even have a negative sign. Finally, although in the third principal component own firm's technology and foreign technology still have the greatest weights, they are of opposite signs. This suggests that if the maximum number of explanatory variables to be estimated in the model allows, it would be recommended to estimate these two variables separately.[4]

Table II.4

Principal Components Analysis

Component Number	Percent of Variance	Cumulative Percentage
1	39.26832	39.26832
2	20.27639	59.54471
3	18.52327	78.06798
4	14.48732	92.55529
5	7.44471	100.00000

Variables' weight:

Variable*	1st PC	2nd PC	3rd PC
OF	0.27778	0.525127	-0.724424
SB	0.462345	0.188838	-0.0674758
UR	0.588704	-0.303159	-0.0205756
EF	0.565658	-0.348124	0.192329
FT	0.206238	0.689555	0.658212

* The sources of technology development are:
OF - Own firm.
SB - Suppliers/Buyers.
UR - University/Research Institute.
EF - Engineering firm.
FT - Foreign technology.

The results of all principal components analysis used in this

[4] As we will see in chapter VI, given the importance for our analysis of the determinants of main sources of technology, we estimated the probit model for each of the five alternative sources.

study are summarized in ANNEX 2.

ii- Cluster analysis

Cluster analysis allows to group observations from a multivariate data set into clusters of "similar" points. This procedure is employed here to cluster industries with similar patterns with regard to certain responses.

In the cases where the dependent variable was a single item, like the firm's degree of preparation to face foreign competition, the clustering method that we adopted was the seeded method on the selected explanatory variables. This method uses a beginning set of pre-specified seed points, that will be used to start the clusters. Each additional case is then matched to the nearest seed point. Here, the initial set of pre-specified seed points will be the six points in the scale indicating the degree of intensity of the response.

In the cases where the dependent variable is a set of possible responses, such as in sources of technology, we used the average hierarchical clustering method on the selected set of dependent variables. This method starts with the 19 industries as being the initial 19 clusters and reduces the number of clusters one at a time by joining each cluster to another until the pre-specified number of desired final clusters.

The results of all cluster analysis used in this study are summarized in ANNEX 3.

II.2.3- Ordered Probit and Logit Models

The types of econometric models that are required to work with the survey's data are ordered probit and logit models. These models have been applied for analyzing ordered multinomial-choice variables such as results of taste tests, opinion surveys, voting outcomes, levels of insurance coverage, degrees of employment (unemployed, part time, or full time), etc. (Greene, 1990).[5]

The multinomial logit or probit models would not take into account the ordinal nature of the dependent variable. In this case, the dependent variables will vary from 0 to 5, indicating the degree of intensity of the response (e.g., 0 = not at all prepared to face foreign competition, 5 = very prepared to face foreign competition). In the multinomial models, the dependent variable would represent, for example, distinct types of occupation (1=menial, 2=blue collar, 3=white collar, etc), where there is no ordinal nature attached to it.

On the other hand, ordinary regression analysis fails to take into account the fact that the dependent variable assumes only discrete values that represent simply a ranking. McKelvey and Zavoina (1975), in their comparison of the regression model and ordered probit model conclude the following:

> ... the failure of the regression model to describe the *observed* data is due to the inherent loss of information that is introduced when the continuous dependent variable is measured by gross techniques which lump together and identify various portions of the scale. The net effect is

---

[5] Maddala (1983), classifies this type of models as discrete regression models for polychotomous ordered categorical variables (pp.13-14).

> that if this is in fact the process by which the data have been generated, there is a correlation between error and regressor when regression is applied to the *observed* data. Consequently, a bias is introduced into the estimate of ß which is dependent on the distribution of the independent variable. This bias may, in some cases, have the undesirable effect of causing regression analysis to severely underestimate the relative impact of certain variables. (p.119)

The ordered probit and logit models have similar assumptions to those of the linear model, for use when the observed dependent variable is ordinal. Moreover, as Mckelvey and Zavoina (1975) states, "this model is an extension of the dichotomous probit and logit model, and assumes that the ordinal nature of the observed dependent variable is due to methodological limitations in collecting the data, which force the researcher to lump together and identify various portions of an (otherwise) interval level variable" (p.103).

The models are based on the following specification:

$$z = \beta' x + \epsilon, \qquad (1)$$

$\epsilon \sim N[0,1]$,[6]

where z is the underlying-unobserved response variable, x is a set of explanatory variables, and ϵ is the residual. The observed counterpart of z is y which is a categorical variable with J response categories.[7]

---

[6] For the case of the probit model. The model can also be estimated with a logistically distributed disturbance. As Greene (1990) states, "this is a trivial modification of the formulation and appears to make virtually no difference in practice" (p.704).

[7] In the dichotomous probit and logit model, J would be equal to one, i.e., y would only be either one or zero.

$$
\begin{aligned}
y &= 0 \quad \text{if } z \le 0, \\
&= 1 \quad \text{if } 0 < z \le \mu_1, \\
&= 2 \quad \text{if } \mu_1 < z \le \mu_2, \qquad\qquad (2) \\
&\ \vdots \\
&= J \quad \text{if } \mu_{J-1} < z.
\end{aligned}
$$

The μ's are thresholds to be estimated simultaneously with ß. In the survey, for example, the respondents choose between six cells (J = 0,1,...,5), in order to express their feeling with respect to the intensity of their preparedness for competition. Those responses can be explained by measurable factors, x, and unobservable factors, ϵ.

When assuming that ϵ is normally distributed and normalized at mean equal to zero and variance equals to one, one has the following probabilities:

$$
\begin{aligned}
\text{Prob}[y = 0] &= \Phi(-ß'x), \\
\text{Prob}[y = 1] &= \Phi(\mu_1 - ß'x) - \Phi(-ß'x), \\
\text{Prob}[y = 2] &= \Phi(\mu_2 - ß'x) - \Phi(\mu_1 - ß'x), \qquad\qquad (3) \\
&\ \vdots \\
\text{Prob}[y = J] &= 1 - \Phi(\mu_{J-1} - ß'x)
\end{aligned}
$$

where $\Phi()$ represents the cumulative standard normal density function.

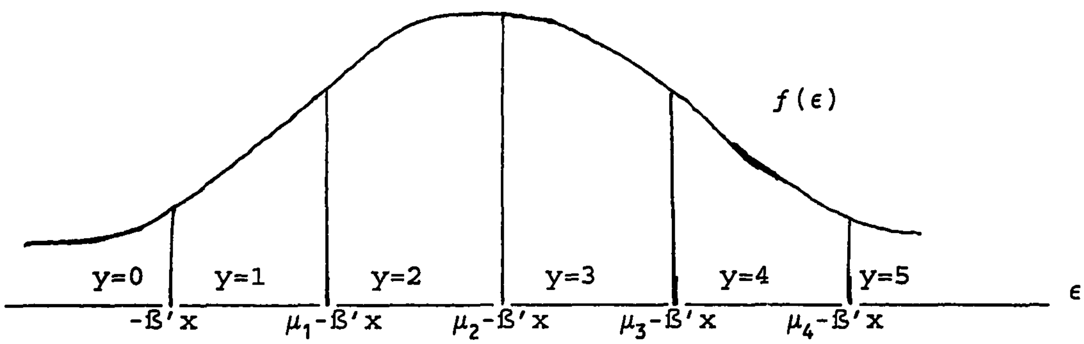
In order for all probabilities to be positive, one must have

$$0 < \mu_1 < \mu_2 < \ldots < \mu_{J-1}.$$

The figure below shows the probability distribution when the dependent variable takes six ordered values (y=0,1,...,5).

Figure II.1

Probabilities in the ordered probit model



Maximum likelihood method was applied to obtain the estimators of the population parameters of the model (ß's and μ's).[8] In a model with K independent variables and J categories, there are K(J-1) parameters to estimate. Aldrich and Nelson (1984) suggest that, even for large sample sizes, K(J-1) should not exceed 50.[9]

The econometrics package that we used in our estimations was the one developed by Greene (1991), which is based on the model described above, originally developed by Mckelvey and Zavoina (1975). The output of the regression gives the individual significance level of all ß's and μ's. Hypothesis test for the

[8] Mckelvey and Zavoina (1975) report that the iterative method of solution based on the Newton-Raphson iterative procedure converges to the global maximum of the likelihood function (p.109).

[9] p.73.

overall significance of the independent variables is based on the likelihood ratio, which has a chi-squared distribution with the number of degrees of freedom equal to the number of explanatory variables. The chi-squared statistic given in the output of the estimation is a valid test statistic for the hypothesis that all slopes of the nonconstant regressors are 0.

Although it is possible to calculate an estimated R^2, an equivalent measure to the coefficient of determination in regression analysis, its results would have to be used with some caution. As Mckelvey and Zavoina (1975) state,

> ... in probit analysis, unlike in regression analysis, we cannot observe the residuals about the regression plane or, indeed, even the deviations of the dependent variable, Y, about its mean... Consequently the estimated R^2 is also an estimate of the true R^2, and in order to make inferences about the true R^2, we should know the distribution of the estimated R^2, which we do not presently know. (p.112)

Since Greene's econometric package does not calculate estimated R^2, as a measurement of the overall fit of the model, we built a table comparing the predicted probabilities calculated at the mean value of the regressors and the observed frequencies.

In the probit and logit analysis, the interpretation of the ß's is distinct from the one in regression analysis. Here, the marginal effects of changes in the regressors will give the increment in the probability of being in a higher (or lower) response category. For the case where the dependent variable has six ordered categories, the marginal effects are calculated as follows:

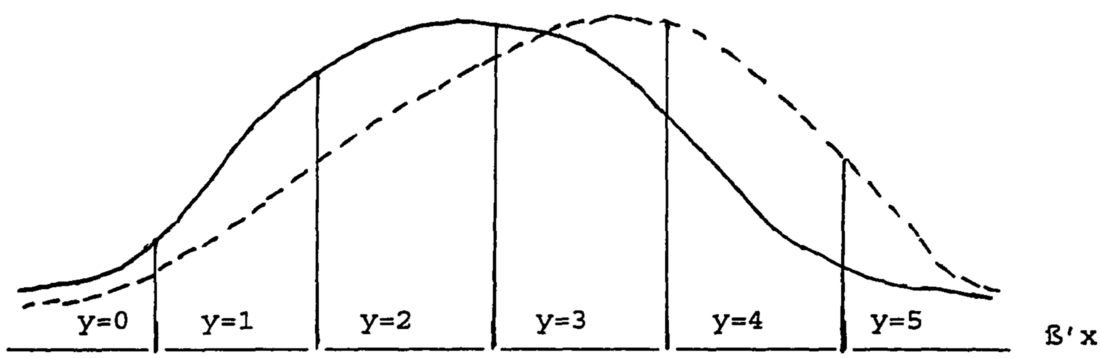
$$\frac{\partial Prob[y=0]}{\partial x} = -\ \phi(ß'x)ß,$$
$$\frac{\partial Prob[y=1]}{\partial x} = ((\phi(-ß'x) - \phi(\mu_1 - ß'x))\ ß,$$
$$\frac{\partial Prob[y=2]}{\partial x} = (\phi(\mu_1 - ß'x) - \phi(\mu_2 - ß'x))\ ß, \qquad (4)$$
$$\frac{\partial Prob[y=3]}{\partial x} = (\phi(\mu_2 - ß'x) - \phi(\mu_3 - ß'x))\ ß,$$
$$\frac{\partial Prob[y=3]}{\partial x} = (\phi(\mu_3 - ß'x) - \phi(\mu_4 - ß'x))\ ß,$$
$$\frac{\partial Prob[y=5]}{\partial x} = \phi(\mu_4 - ß'x)\ ß.$$

where $\phi()$ is the standard normal density function. Note that for each x, the marginal effects sum to zero. For each equation to be tested, we calculated a matrix with those partial effects.

The figure below shows the effect of a unit increase in one of the explanatory variables while holding ß's and μ's constant. The probability distributions of y and z are shown in the solid curve. Assuming the corresponding ß to be positive, with the increase in x, the probability distribution shifts to the right (dashed line). The effects in the probabilities of the two extremes, Prob[y=0] and Prob[y=5], are clearly negative and positive, respectively. However, in the middle cells the direction of the marginal effects are not straightforward. It will depend on the value of the two densities involved in their calculation.

Figure II.2

Effect of a unit increase in on of the explanatory variables



The figure above could be the illustration of the following example. The estimated coefficient of the explanatory variable "share of exports in total revenue" on the dependent variable "determinants of a firm/industry preparation for foreign competition" is .088394 and was significant at the .001 level. Its calculated marginal effects on the probability distribution of the degrees of preparedness for foreign competition were:

Table II.5

Marginal Effects

y	$\frac{\partial P(y= \ )}{\partial x}$
0	-.990424E-02
1	-.190850E-01
2	-.624582E-02
3	.963218E-02
4	.172261E-01
5	.837679E-02

The interpretation of these results are as follows. The positive sign of the coefficient indicates that the greater the share of exports the more prepared for foreign competition a firm is expected to be. The marginal effects tells by how much the population probability distribution of the levels of preparedness for foreign competition will change, if the average share of exports of the population increases by one unit, what in the present case, means an average increase of its export share of five percentage points. For example, the probability of a firm to be at level y=1 will decrease by 1.9% while its probability to be at level y=4 will increase by 1.7%. These changes in the probabilities for each level of y are illustrated by the movement to the right of the probability distribution in the previous figure. One can also see in the table below the actual probability distribution and the expected new probability distribution after the unit increase in the independent variable.

Table II.6

Actual and Expected New Probabilities

Y=	Actual Prob.	New Prob.
0	.06633	.05643
1	.21939	.20031
2	.23693	.23014
3	.25000	.25963
4	.16667	.18390
5	.06122	.06960

With one unit increase in the average share of exports of the population, the number of firms that would be on the upper half level, i.e., firms that are medium to very well prepared for foreign competition (Y = 3, 4 and 5), would increase from 47.8% to 51.3%.

When estimating the defined equations to distinct subsamples (clusters and specific industries), we will be able to identify their specific characteristics by looking at the signs and level of significance of each explanatory variable in each subsample. A summary table with these results will be built for each dimension to be analyzed.

In the next chapter we will present the four dimensions of firms and industries facing the Brazilian trade liberalization policy that we are going to analyze in this study, and verify whether in each of the survey's responses one can notice industry specific characteristics.

III - FOUR DIMENSIONS ON THE ANALYSIS OF THE OPENING OF THE ECONOMY

In the first section of this chapter we will present the four dimensions of the analysis of the current state of Brazilian firms and industries facing the perspective of greater opening of the economy. The main motivation of the analysis of these economic questions and the limitations imposed by the survey data used in this study will also be presented. In the second section, following the methodology and steps described in the previous chapter, we will start by testing for the presence of interindustry variations in each of the CNI-1991 survey's responses in order to verify whether one can notice industry specific characteristics.

III.1 - Selected Dimensions to be Analyzed and their Motivations

The following chapters seek to investigate four basic dimensions to be presented here that could give insights in understanding the determinants of performance of firms and industries in the Brazilian economy, given their past strategies and government policies. This study becomes of even greater importance at the present moment given the new economic environment faced by the Brazilian firms since March 1990, when the administration of President Collor started its program of greater opening of the economy. The analysis of these four dimensions to be stated below will allow us to better understand how a coherent set of policies towards a greater opening of the economy should be defined in order to attain the objectives of greater economic growth. In other words, this is an attempt to identify the ideal timing and the best set of incentives in order to allow an efficient adjustment of firms/industries into a more open economy. Such a strategy would reduce unnecessary negative impacts in domestic production and employment and would allow for the establishment of a better prepared industry to face greater international competition.

The issues that we consider of particular importance to be analyzed are related to the determinants of the degree of competitiveness and international insertion of firms/industries, to the current types of adjustment needed for the firms/industries in this new environment, to the process of flow of new technologies, and to whether domestic technological capabilities are required in order for firms to survive with the opening of their domestic markets.

We are concerned with identifying the existence of industry-specific as well as firm-specific determinants of performance. Industry-specific determinants are related to characteristics such as the following: industry market structure, degree of global integration of the industry, the efficient plant and size of market required, the location of the industry in the productive structure, government's industrial and regulatory policies, etc. On the other hand, the heterogeneity of firms, even within the same industry, is in a great part determined by the distinct strategies adopted by each firm with respect to product diversification, external markets, technological strategies, ownership, etc. Those distinct strategies are what would, in the medium and long term, determine the different degrees of capability of those firms to compete in a more open economy.

The dimensions to be investigated and a list of their basic explanatory variables and motivations, are described in the following sections. The hypothesis behind each explanatory variable will be presented in the subsequent chapters.

III.1.1 - DIMENSION 1: What are the main determinants of a firm/industry preparation for foreign competition? (11)[1]

With this question, we intend to evaluate the importance of previous firms' strategies and government policies, such as import protection and export promotion in the determination of the degree of preparedness to face foreign competition. Moreover, we will evaluate the relation between the latter and industries' market characteristics, as well as with respect to their perceived types of adjustment and rationalization of production that are necessary with the trade liberalization. The main motivation for this question is that a better understanding of those relations is fundamental to defining the coordination and adequate timing of policies (trade, industrial, science and technology, property rights, etc.) in the context of a successful opening of the

[1] The number in parenthesis refers to the number of the response in the Survey as stated in ANNEX 1.

economy.

The initial explanatory variables determining firm/industry preparation for foreign competition to be discussed are:

- Whether the firm already experience the competition of imported goods. (10)
- Average share of exports in firm's total revenue. (12)
- Perceived frequency of adjustments in the industry with the liberalization policy. (15-27)
- Perceived current needs to rationalize production. (38-43)
- Perceived market structure. (49-54)

III.1.2 - DIMENSION 2: What are the main determinants of a firm/industry share of exports in its total revenues? (12)

This question is a corollary of the previous one. If exports are an indicator of the degree of competitiveness of a firm, it would be interesting to investigate what makes a firm export.

In the Brazilian case, the opening of the economy should endeavor to maintain a more stabilized economy, together with new legislation increasing foreign investment opportunities, in order to generate a greater amount of foreign capital inflows compensating for a larger deficit in the current account during the adjustment period of the trade liberalization program. Moreover, the government could also attempt to maintain its trade accounts somewhat balanced in terms of its increases of imports and exports, hence the importance to answer the above question in order to determine which policies could lead to an increase in the share of exports in a firm/industry's total revenue.

In 1990, the Collor administration started its policy by reducing import tariffs and administrative controls, but simultaneously it eliminated the ongoing system of incentives for exports such as exchange rate policy and fiscal and credit subsidies.[2] With the change in the economic team at the beginning of 1992, those incentives were partially reestablished which, together with a stagnant economy, allowed the maintenance of increasing trade surpluses.[3] During the economic recovery of 1993 and 1994, the drops in trade surplus were compensated by increases in net foreign investments. Due to the consumption boom caused by the "Real" stabilization plan, implemented in mid-1994, and the maintenance of an overvalued real exchange rate, it seems that the trade balance tends to deteriorate even further and that foreign investment inflows alone will not be sufficient to compensate for such imbalance. A fall in reserves can be a temporary solution, but a strategy leading to the recovery of the trade balance should be considered as a better alternative than having to encounter a much more difficult adjustment as the one faced by Mexico since its crisis of December 1994.

The analysis of this second dimension will contribute to identify what are the conditions, if any, that lead to a greater

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[2] During 1990 and 1991, the monetary policy led to a real exchange rate appreciation, a tendency that was reversed in the subsequent years until the start of the Real Plan in mid-1994.

[3] World Bank (1994).

share of exports in a firm/industry's total revenue. Moreover, if our hypothesis to be tested in dimension 1 that exporting firms are the most prepared to face foreign competition is correct, the creation of conditions leading to the increase in exports would also contribute to the improvement of the degree of firms' preparedness to face foreign competition in the domestic markets.

The initial explanatory variables determining a firm/industry share of exports in its total revenue to be discussed are:

- Location of firm. (5,55)
- Perceived need for adaptation after trade liberalization. (14)
- Perceived importance of import restrictions of informatic goods on industry's modernization. (29)
- Perceived obstacles to export. (30-37)
- Perceived market structure. (49-54)

III.1.3 - DIMENSION 3: What are the determinants of distinct adjustment options with liberalization policy within firms and industries? (15-27)

The adjustment options to be undertaken by each firm/industry are not only an indicator of their main current deficiencies within the liberalization of the economy, but will also give a better idea of their future situation in terms of capital ownership, degree of vertical integration, diversification of production, and capital and human resources investments. By manipulating the main determinants of the adjustments decisions, we might be able to influence the future profile of the Brazilian industry.

The adjustment options included in the survey are:

- Acquisition of new machinery and equipments. (15)
- Rationalization of production lines. (16)
- Reduction of degree of vertical integration. (17)
- Increase in imports of components. (18)
- Substitution of own production for imported products. (19)
- Reduction of degree of diversification of line of production. (20)
- Association with multinational enterprises. (21)
- Mergers and consolidations. (22)
- Increase in technology investments. (23)
- Increase of purchase of foreign technology/products licensing. (24)
- Extension of human resources training. (25)
- Creation/expansion of quality control programs. (26)
- Renegotiation of suppliers' prices. (27)

The initial explanatory variables determining firm/industry's adjustment decisions to be discussed are:

- Share of exports in total revenue. (12)
- Perceived velocity of the current trade liberalization. (9)
- Exposure to foreign competition. (10)
- Evaluation of current informatic goods' import restrictions on industry's modernization. (29)
- Perceived needs to rationalize the production process. (38-43)

- Sources of firms' technology. (44-48)
- Perceived market structure. (49-54)
- Firm's location. (5,55)

III.1.4 - DIMENSION 4: What are the determinants of firm/industry's main sources of technology? (44-48)

A reduction of import restrictions of equipments will allow for a faster modernization of the domestic industry. On the other hand, part of the domestic machinery and equipment industry will probably not survive with the foreign competition. Moreover, the new legislation on intellectual property rights that is currently under preparation could completely change the incentives for innovation and the mechanisms of adoption of new technologies. In the long run, the effect of those changes in the domestic technological capabilities and competitiveness are still not very clear. In order to define a domestic technological strategy, it is important to have answers to questions such as what are the dynamics of the flow of new technologies, and whether or not and in which areas do domestic technological capabilities are required in order for Brazilian firms to survive with the opening of its markets. When analyzing this dimension, we will also discuss the functioning of markets for technology in the current international context and the recent Brazilian Science and Technology (S&T) program.

Although one cannot deal here with all the above aspects, this analysis will allow us to understand the current relationship between main sources of technology and specific characteristics of firms and industries, such as their market structure, degree of openness to the foreign markets, location and previous exposure to foreign competition that emerged from the Brazilian previous set of policies. This could give some guidelines on relevant aspects to be considered when defining future science and technology policy and its legislation.

The main sources of technology included in the survey are:

- Firm's own technology development. (44)
- Suppliers/buyers technology development. (45)
- University/research institutes technology development. (46)
- Engineering firms technology development. (47)
- Foreign technology - technology developed abroad. (48)

The initial explanatory variables in determining potential firm/industry's sources of technology to be discussed are:

- Firm's location. (5,55)
- Share of exports in firm's total revenues. (12)
- Perceived exposure to foreign competition. (10)
- Perceived market structure. (49-54)

III.1.5 - Limitations imposed by the survey

The list of possible explanatory variables for each dimension to be analyzed is rather large and at the same time limited by the scope and methodology of the survey. We were unable, for example, to use measurements of firm size as an explanatory variable in any of the four dimensions. At an aggregate level, all industries together, firm size could not be used since the average firm size in each industry, when measured either by the number of employees or by total revenue, differs considerably.[4]

When looking at firms in each industry separately, these variables were also not adequate because the survey dealt only with a relatively homogeneous group of medium and large size firms per industry. The lack of variability on firm sizes can be seen by the fact that the difference between the lower and upper bounds of a 95 percent confidence interval for industry means did not exceed 1.8 in a scale from 1 to 6 for number of employees and 0.4 in a scale from 1 to 3 for total revenues.

The next step will be to test for the presence of significant variance between industries at the two and four digits of IBGE classification for all the survey responses.

III.2 - Testing the Presence of Interindustry Variations in the Survey's Responses

As discussed in the methodological chapter, when analyzing the survey questions, we would like to identify not only differences at the firm level but also at the industry level. The one-way analysis

[4] For example, the average number of employees in firms from the leather products industry was of 400 while for the tobacco industry it was of 4,000.

of variance was undertaken in order to check the presence of interindustry variation in the responses of the questionnaire. If interindustry variations are significant this would means that there exists important industry specific characteristics that are relevant in determining its performance.

Although the variability around each industry was large in absolute terms, it was relatively small when compared with the variability among industries. This confirms the presence of significant interindustry variation in the responses of most of the questions.

At the two-digit industry level of the IBGE classification, interindustry differences are significant at the 0.01 level for 69 percent of the questions; and at 0.05 level for 85 percent of the questions. At a lower level of aggregation (four digits), interindustry differences were significant at 63 and 75 percent respectively.[5]

The substantial intraindustry variations in the responses of the survey leads to the conclusion that there exists important firm specific characteristics that are relevant in determining its performance. We must admit that part of this variation could be due to the still heterogeneous lines of business that are aggregated in the same type of industry as defined by the IBGE classification. Moreover, an important source of intraindustry variation is simply

[5] At the two-digit industry level of aggregation, the questions with no significant interindustry variation at 0.05 level were: 28,30,39,41,43, and 51. Question 51, about the intensity of rivalry among producers in the industry, was significant at 0.1 level.

due to the "inherently subjective nature of the semantic scales used in the survey".[6]

Given the presence of significant intra- and inter-industry variation, when estimating the ordered probit model, whenever the sample size is large enough, we will verify whether the estimates of the overall results are significantly distinct from the estimates we would obtain at specific industry or group of industries level.

The subsequent chapters will pursue the analysis for each of the dimensions proposed in the first section of this chapter. The main hypothesis with respect to the effect of each explanatory variable on the determination of each dimension will be discussed and the analytical steps described in the methodological chapter will be followed.

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[6] Klevorick, et al. (1987). In our survey the "semantic scales" is due to the fact that the survey questions are based on a one to six scale indicating increasing degree of intensity. In his study, Klevorick, et al. (1987) faced the same kind of problem when using a similar type of survey to analyze the appropriability of the returns from industrial research and development. As here, the authors preferred not to adopt techniques to control among respondents in means and variances, because it would limit part of the informative dimensions of the data.

IV - DETERMINANTS OF PREPARATION FOR FOREIGN COMPETITION

In this chapter we will investigate the determinants of a firm/industry preparation for foreign competition. We shall evaluate the importance of previous firms' strategies, such as product diversification and degree of vertical integration, as well as the effects of government policies, such as tariff protection and export promotion on the degree of preparedness to face foreign competition. Moreover, we will look at the relation between the latter and industry-specific market characteristics, such as the degree of rivalry among producers in a market, and the firms' perceived types of adjustment and rationalization of production that are imperative with trade liberalization in each industry.

A better understanding of these relations is fundamental in defining a coherent and, eventually, industry-specific set of policies towards a successful opening of the economy. Among these policies are included the definition of the adequate timing for trade liberalization, the establishment of an appropriate property rights regime, a science and technology policy directed to the creation of domestic technological capabilities, the development of export promotion mechanisms, and the modernization of the country's basic industrial infra-structure.

In the next section we will discuss our hypothesis with respect to the variables that affect the firm/industry preparation for foreign competition.

IV.1 - Initial Hypothesis[1]

- *Explanatory Variable 1 - Whether the firm already experiences the competition of imported goods*. (10) (1-very weak, 6-very strong)

As a first impression, one would expect that, in general, firms in an industry that already experienced competition of imported goods would be the more prepared to face foreign competition after trade liberalization. And one would think that this should also be the case when estimating the model for firms within each industry, reflecting firms' distinct lines of products. But, in fact, this is only true for a firm in an industry that was already facing very low trade barriers.[2] If a firm operating in an industry with high trade barriers still faces foreign competition, then without those barriers this firm would be, at least at the beginning, in a much worse shape. Since Brazilian protection levels were high at the moment of the survey,[3] we would expect a negative coefficient for this variable when estimating the model for all firms, i.e., the greater the level of foreign competition that a firm faces when there are high trade barriers, the less prepared this firm will be to compete with the trade liberalization.

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[1] The number in parenthesis after each variable corresponds to the question number in the survey (see ANNEX A).

[2] Or, for a firm that already exported due to export incentives as we will discuss later.

[3] In 1990, the average import tariff was of 32.2 percent with a standard deviation of 19.6 (CNI, 1991) and, as discussed in chapter I, non tariff barriers were very high.

- *Explanatory Variable 2 - Average share of exports in firm's total revenue.* (12) (see ANNEX A for scale)

The expected sign of the influence of this variable in the degree of preparation for foreign competition is clearly positive. This would only not be clearly the case if the same firm would have distinct lines of products attending different markets and/or under different protection regimes.

It will be interesting to verify the importance of this variable in the determination of the preparedness for competition of a specific firm and of an industry as a whole. Based on that, we could better establish the importance of an export policy for the country during the period of increasing liberalization of imports.

- *Explanatory Variable 3 - Perceived frequency of adjustments in the industry with the liberalization policy.* (15-27) (1-not frequent, 6-very frequent)

In the survey, there were thirteen distinct options of adjustments that could be undertaken by a firm with the trade liberalization.[4] Respondents answered with what frequency each type of adjustment was expected to be made. These adjustment options could be interpreted as indicators of the degree of distinct types of deficiencies faced by firms/industries at the moment of trade liberalization. It is expected that the greater the need for adjustments, the less prepared they are to face foreign competition. The expected coefficient for all adjustment options

[4] The entire list will be presented in the next section.

are negative. A more detailed description of the adjustment options will be made in the following section, when selecting through principal components analysis the explanatory variables to be included in the model.

- *Explanatory Variable 4 - Perceived current needs to rationalize production.* (38-43) (1-little necessary, 6-strongly necessary)

By rationalization of production, the survey means improvements in quality control, management of stock, production process, packaging, distribution, and better product. The expected coefficient for all types of rationalization of production are also negative, by similar reasons as the ones of explanatory variable 3, i.e., these rationalization needs could be interpreted as indicators of the degree of distinct types of deficiencies faced by firms/industries at the moment of trade liberalization. It is expected that the greater the need for rationalization of production, the less prepared they are to face foreign competition.

- *Explanatory Variable 5 - Perceived market structure.* (49-54) (1-very low, 6-very high)

Six competitive forces were included in the survey in order to define the market structure of each industry. They are the following.

Suppliers market power (49)
Buyers market power (50)
Rivalry among producers in the industry (51)
Velocity of introduction of new products (52)
Potential entry of new competitors (53)
Potential entry of imported goods (54)

The first five competitive forces corresponds to Michael E. Porters' scheme of industry structural analysis.[5] The last variable, potential entry of imported goods, was introduced to highlight firms' perceptions of the potential effects of the trade liberalization program.

The expected coefficient signs for the six indicators with respect to the degree of preparedness to face foreign competition could be divided into two groups. We would expect negative coefficient signs with respect to suppliers' and buyers' market power as well as with respect to the potential entry of new competitors and imported goods. If a firm perceives that some of these four variables are highly present in its market, it indicates that the firm's position is weak in terms of the limitations the firm has in its production process and/or product differentiation decisions. On the other hand, we would expect that a more competitive market, when measured here by the degree of rivalry among producers and the velocity of introduction of new products, would be more prepared to face foreign competition, i.e., a positive coefficient. A firm that is located in markets where these types of competitive forces are strongly present, must necessarily be highly dynamic and competitive, otherwise it would not survive.

In the next section we will apply principal components analysis to, whenever possible, combine correlated explanatory variables in order to specify the variables to be included in the ordered probit and logit models. Correlation analysis will also be

[5] Porter, 1985.

used for a preliminary check of the initial hypothesis.

IV.2 - Correlations and Principal Components Analysis

- *Explanatory Variable 1 - Whether the firm already experiences the competition of imported goods*. (10) (1-very weak, 6-very strong)

The overall correlation at the firms' level between "Preparation for Foreign Competition" and "Whether the firm already experience the competition of imported goods" was negative as expected (Corr(11,10)= -.20). At the two digit industry level - excluding the tobacco industry that has only one respondent- the correlation of the mean responses was of minus .23, reflecting the presence of industry specificities. When calculating the firms' correlation within each industry the majority of the correlations were also negative.[6] The only two industries with a positive correlation were paper products, and clothing and footwear, both industries with high average shares of exports on their total revenues.[7]

It is worth mentioning here that responses to question 54, "Industry's perception of potential entry of competing imported goods" are also negatively correlated with the dependent variable

[6] As mentioned in chapter II, the negative correlation at the individual firm level within each industry, could be in part due to the heterogeneous lines of products that are included in the same industry as defined by the IBGE. In that case, as in the negative correlation observed at the industry means, the reasons could be attached mainly to the specific characteristics of each market.

[7] They are among the five industries with the highest average share of exports in total revenue in the survey and, as shown in chapter I, by 1991 they had a revealed industry competitiveness indicator of 1.08 and 1.22, respectively, showing the existence of competitive advantages in these industries.

"Preparation for foreign competition" (-.30 at firms' level and -.55 at industry's level). The explanation for such results are similar to the ones mentioned for the explanatory variables "Whether the firm already experiences the competition of imported goods". The latter is significantly positively correlated with question 54 (Corr(54,10)= .60, at the firm level).

However, our suspicion that this negative correlation observed in most industries is due to the high levels of protection of the economy merits a deeper discussion. The table below shows the Brazilian average nominal tariffs and effective protection for each industry for 1989 and 1985 respectively.[8]

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[8] The effective protection indicator takes into account not only the nominal tariff in the final good but also the tariffs that protect the production of inputs used in the production of that final good. It is considered a more appropriate indicator of the degree of protection than the one given by the tariff schedule. (Hahn, 1992)

Table IV.1

Brazilian Average Nominal Tariffs and Effective Protection (%)

Industry	Nominal Tariff [a/] (1989)	Effective Protection (1985)
Mining	24.8	-10.7
Nonmetallic mineral products	44.8	10.3
Metal Products	46.7	53.0
Machinery	51.6	5.6
Electrical and communications equip.	54.5	54.7
Transportation equipment	52.2	-4.4
Wood products	38.5	45.6
Paper products	37.2	44.1
Rubber products	64.4	43.3
Leather products	51.1	29.0
Chemicals	42.3	63.2
Pharmaceutical and veterinary	43.4	117.8
Perfumes, soaps and candles	76.5	26.3
Plastic products	61.7	189.0
Textiles	84.0	112.1
Clothing and footwear	82.1	231.4
Food products	42.9	45.8
Beverages	78.4	-1.7
Tobacco products	88.8	-79.6
Printing and publishing	34.1	-5.3
Miscellaneous industry	60.2	96.7
Mean:		
Agriculture	29.0	-24.6
Manufacturing	51.2	42.9

a/ It includes existent overtaxes.

Source: Braga and Tyler (1990) p.5 and 22 (reproduced from Oliveira, 1992).

The correlation of these levels of protection with the average industry exposure to foreign competition (10) and preparedness for foreign competition with the trade liberalization (11) can be seen in the next table. The negative correlation between exposure to foreign competition and levels of protection shows the effectiveness of the trade barriers, i.e., the industries that had the higher levels of protection were the ones the least exposed to foreign competition. On the other hand, the positive correlation between protection levels and preparedness for foreign competition could be an indicator that industries developed under protective markets were relatively successful in attaining international competitiveness.

Table IV.2

Sample Correlations

Variables	Levels of Protection	
	Nominal Tariff	Effective Protection
Exposed to Foreign Competition (10)	-.44	-.41
Prepared for Foreign Competition (11)	.37	.21

Source: Author's calculations.

The above inference, however, is only in part supported by a deeper analysis of the following data. Firms, in general, declared that they did not face very strong competition of imported goods. Nearly 80 percent of the firms responded between 1 and 3, i.e., the lower half of the scale.[9] Nonetheless, with respect to the

[9] The four industries that reported to face on average the highest levels of competition from imported goods were electrical and communications equipments, machinery, and pharmaceutical and veterinary products. As shown in chapter I, in 1991, all four industries showed an industry competitive disadvantage as measured

preparedness for foreign competition, the responses were more evenly distributed, having a greater concentration around the four central points of the scale (86.3% of firms). Looking at the crosstabulation of these two variables in the table below, one can notice that firms/industries' exposure to foreign competition was, in general, low and the perceived degree of preparedness to compete with foreign firms was almost evenly distributed. This suggests that firms/industries that had a protected market not necessarily became more prepared to face foreign competition. Some firms/industries could have, for distinct reasons, missed the eventual opportunity to use that period of protection to "catch up". The electrical and communications equipment industry, for example, which was in the past years highly protected and had a previously scheduled import barrier reduction, was the industry that declared itself among the two least prepared to face foreign competition.[10] The computer sector that had high protective barriers in the last decade is included in this industry.[11]

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by the revealed industry competitiveness indicator.

[10] In the CNI's survey, 77.8% of firms from the Electrical and communications equipment industry and from Printing and publishing industry declared that they were weakly prepared for foreign competition, i.e., their responses were in the lower half of a scale from 1 to 6.

[11] We should notice that the electrical and communications equipment industry was the one that on average declared to currently face the highest level of foreign competition. However, this average was of only 3.1, i.e., a medium-to-low level of competition.

Table IV.3

Crosstabulation of Responses to Questions "Preparation for Foreign Competition" (11) and "Whether the firm already experience the competition of imported goods" (10) [a/]

Firm's Exposure to Foreign Competition	Scale of Perceived Preparation for Foreign Competition						Row Total
	1	2	3	4	5	6	
1	19 2.8	19 2.8	41 6.1	59 8.8	49 7.3	34 5.1	221 33.1
2	11 1.6	43 6.4	42 6.3	41 6.1	35 5.2	1 .1	173 25.9
3	8 1.2	36 5.4	32 4.8	39 5.8	18 2.7	2 .1	135 20.2
4	3 .4	17 2.5	21 3.1	13 1.9	6 .9	1 .1	61 9.1
5	4 .6	15 2.2	18 2.7	8 1.2	2 .3	4 .6	51 7.6
6	2 .3	6 .9	6 .9	8 1.2	2 .3	3 .4	27 4.0
Column Total	47 7.0	136 20.4	160 24.0	168 25.1	112 16.8	45 6.7	668 100.0

a/ For each cell, the first line is the absolute frequency and the second line is the percentage based on total frequency.
Source: Author's calculations.

- *Explanatory Variable 2 - Share of exports in firm's total revenue.* (12)

In the survey, firms that export more were in general the ones that declared to be the most prepared to face foreign competition with trade liberalization, confirming our initial hypothesis. The overall sample correlation at firm level was of .16 and was significant at .01 level. Moreover, at each individual industry, the correlations were all significantly non negative. This would suggest that for a successful trade liberalization policy to occur, an increase in the export shares in firms' total revenues would be required not only in order to equilibrate the trade balance, but also as an instrument to improve firms' preparedness to face a greater competition in the domestic market due to the reduction of import barriers. As we discussed in chapter I, the share of exports in total production indeed increased from 9.2 percent in 1990 to 13.2 percent in 1994, showing a more aggressive strategy towards increased competitiveness.

- *Explanatory Variable 3 - Perceived frequency of adjustments with liberalization policy.* (15-27) (1-not frequent, 6-very frequent)

Looking at the results of principal components analysis, we were able to arrange the thirteen adjustment options by common patterns into five groups as follows:

Group i:
 Substitution of own production for imported products (19)
 Reduction of line of production diversification (20)
 Increase in imports of components (18)
 Reduction of degree of vertical integration (17)

Group ii:
 Rationalization of production lines (16)
 Extension of human resources training (25)
 Creation/expansion of quality control programs (26)

Group iii:
 Purchase of foreign technology/Products licensing (24)
 Increase in technology investments (23)
 Acquisition of new machinery and equipments (15)

Group iv:
 Mergers and consolidations (22)
 Association with multinational enterprises (21)

Group v:
 Renegotiation of suppliers prices (27)

The main results of the principal components analysis can be found in ANNEX 2.[12] At least one variable in groups i, ii, and iii has significant negative correlations greater than .10 with the dependent variable. Due to significant but very small negative correlation observed between the variables in the last two groups and the dependent variable, they were discarded of further analysis at the present stage of the analysis.

For each of the above defined groups we selected the variable that could be considered the most representative. This procedure was preferred to the summation of their values or any other method of aggregation, since the estimated coefficients would not be very meaningful. The representative variables and their expected coefficient signs are described below.

Group i - *Perceived frequency of substitution of own production for imported products in the industry with the liberalization policy* (19).

This explanatory variable could be an indicator of the degree of substitutability of a firm's products. Some firms/industries have products that are less likely to be substituted due to costs of transportation, different cultures, different climates, etc. Others are simply nontradable types of goods, although, in the industrial sector, these goods are not as common as in services. As

[12] Due to memory limitations, I could not calculate more than 10 variables at each time. When including the omitted variables the results did not suffer any substantial difference. In ANNEX 2, the results for the principal components calculations for each of the principal components groups are also shown.

mentioned in section IV.1, we would expect a negative coefficient sign for this explanatory variable, since the less a firm/industry's product is liable to be substituted, the more prepared this firm would be to face foreign competition.

This explanatory variable could be an indicator of the presence of market distortions. A firm that decides to substitute its own production for imported products will be reducing its degree of diversification and/or vertical integration, becoming more specialized. But, while in some cases one could be looking at a firm that is becoming more globally efficient, in other cases it could be the indication of a potentially successful line of production that has not yet attained its "maturity" and is prematurely vanishing. Which of the above interpretations is the most adequate will depend on the specific characteristics of each industry and production line.

Group ii - *Perceived frequency of rationalization of production lines in the industry with the liberalization policy* (16).

This variable is an indicator of the gap in efficiency of production that was possible given the past protectionist regime. The possible, although not necessary, exception to this rule is the case of firms that were competing in foreign markets in the same lines of product. A negative coefficient sign for this variable is expected, since the greater need for rationalization of production lines with trade liberalization is an indicator of current lack of preparedness to face foreign competition.

Group iii - *Perceived increase in the frequency of purchase of technology abroad and/or licensing of products in the industry with the liberalization policy* (24).

This variable shows which industries depend most on world markets of technology, i.e., which are the industries that most seek to be internationally integrated in these markets in order to be competitive. In general, firms that were less technologically integrated are the ones that would be less prepared for foreign competition with the trade liberalization. This does not necessarily means that a firm does not have its own technological sources, since the survey indicates a positive correlation among those two variables.

It will be interesting to identify which are the industries that most require such international integration. This will be possible by comparing the coefficients of the estimations of the model for distinct groups of industries. A property rights legislation should take into account the specific needs of each industry.

- *Explanatory Variable 4 - Perceived needs to rationalize production*. (38-43) (1-little necessary, 6-strongly necessary)

The six types of rationalization of production contained in the survey are the following:

Better quality control (38)
Better management of stock (39)
Better product (40)
Better production process (41)
Better packaging (42)
Better distribution (43)

Principal components analysis (see ANNEX 2) shows that all six variables have a positive and almost identical coefficient in the first principal component, which alone explains more than 50 percent of the variability. This suggests that all six variables affect the total variability in the same direction. However, the direct linear combinations of the principal components with the dependent variable does not have any interesting economic meaning. For this reason, we decided to look at the sample correlations in order to select the most appropriate representative variable for the perceived needs to rationalize the production. The sample correlations of variables better packaging (42) and better distribution (43) with respect to preparedness for foreign competition were insignificant. Furthermore, among the remaining explanatory variables, better management of stock (39) and better product (40) are highly correlated with better quality control (38). The correlations were of .46 and .52 respectively. Given that, we decided to include better quality control as the explanatory variable for rationalization of production.

The higher need for quality control is an indicator that the firm is less prepared to face foreign competition, i.e., a negative coefficient sign. In the estimations for distinct industries, one can identify which are the ones that have the perceptions of preparedness for foreign competition most influenced by current rationalization of production needs. An industrial policy should give special attention to those industries seeking for greater frequency of rationalization of production.

- *Explanatory Variable 5 - Perceived market structure.* (49-54) (1-very low, 6-very high)

The six types of competitive forces included in the survey in order to characterize the industry market structure are the following:

Suppliers' market power (49)
Buyers' market power (50)
Rivalry among producers in the industry (51)
Velocity of introduction of new products (52)
Potential entry of new competitors (53)
Potential entry of imported goods (54)

Principal components analysis indicates that all six variables have positive coefficients in the first principal component, although the first two variables, suppliers' and buyers' market power, had smaller coefficients than the other four (see ANNEX 2). Here again, it would not be very meaningful to construct an index with those variables since the interpretation of its estimated coefficient would not tell very much in itself. We looked at the sample correlations in order to select the most appropriate representative variable for the perceived market structure. The sample correlation coefficients of these variables with respect to firm's preparedness for foreign competition were neither very significant nor strong. The only exception was the correlation with potential entry of imported goods (Corr(11,54)= -.30). However, since this variable is significantly positively correlated with the explanatory variable 10, "whether the firm already experience the competition of imported goods", which is already included in the model, it would not be very appropriate to choose it as the representative variable.

The evaluation of the degree of rivalry among the producers in the industry (51), was the variable chosen to be included in the final model. We shall see if for specific industries one gets some significant coefficients for this variable. Industries located in markets where rivalry among producers are currently weak but, with the liberalization of imports, markets become highly competitive, will need a more careful attention when defining their pace of liberalization and complementary industrial policy. In order to a firm, under the above circumstances, to survive with the trade liberalization it will necessarily have to become more dynamic and competitive.

In this section, we selected seven explanatory variables to be included in the model. Before the estimation of the model for the entire data set, by applying cluster analysis, we will look whether one can identify some similar patterns among industries in the responses of the selected variables defined above that could be analyzed as separate subsamples of the survey's data.

IV.3 - Cluster Analysis: Identifying Similar Patterns Among Industries

The first dimension of the study that is analyzed in this chapter is concerned with the determinants of a firm/industry preparation for foreign competition.

The explanatory variables, selected by correlation and principal components analysis, to be included in the model are the following.

1 - Whether the firm already experiences the competition of imported goods (10).

2 - Average share of exports in firm's total revenue (12).

3 - Frequency of substitution of own production for imported products in the industry with the liberalization policy (19).

4 - Frequency of rationalization of production lines in the industry with the liberalization policy (16).

5 - Increase in the frequency of purchase of technology abroad and/or licensing of products in the industry with the liberalization policy (24).

6 - Better quality control (38).

7 - Rivalry among producers in the industry (51).

The cluster analysis applied here, allowed us to group industries with similar patterns with regard to their responses on the selected explanatory variables. The results of clustering these variables by seeded method can be found in ANNEX 3. We initially defined six seeds corresponding to the six possible degrees of intensity of the responses. It allowed us to generate six clusters. We have calculated those six clusters using three different combinations of the explanatory variables: first with all variables; secondly with the variables expected to have a negative coefficient; and third, with the variables expected to have a positive coefficient. From the analysis of these three results we defined three groups of industries that were very close in their response pattern. They are the following:

Cluster A: Mining (Ind.# 1)
Wood products (Ind.# 7)
Printing and publishing (Ind.# 20)

Cluster B: Metal products (Ind.# 3)
Chemicals (Ind.# 11)
Plastic products (Ind.# 14)

Cluster C: Transportation equipment (Ind.# 6)
Perfumes, soaps and candles (Ind.# 13)
Clothing and footwear (Ind.# 16)
Food products (Ind.# 17)

There are three industries not included in the above clusters that, given their sample size, can be estimated separately. They are Machinery (Ind.# 4), Electric and communications equipment (Ind.# 5), and Textiles (Ind.# 15).

In the next section, the results of estimations of the ordered probit and logit models for all firms and the selected clusters and industries will be presented.

IV.4 - Results of the Estimations of the Ordered Probit and Logit Models

The results of the estimation of the ordered probit model for the entire sample suggests that all the included determinants of a firm competitiveness demonstrated to be significant and with the expected signs. The only exception is the market structure explanatory variable, "rivalry among producers in the industry", that was not significant. One can find in the table below the results of the ordered probit model estimated for all firms of the survey.[13]

Given the existence of some omitted responses, the sample size was of 588 firms. The hypothesis that all slopes of the nonconstant regressors are zero at .0001 significance level is rejected. Most of the regressors were individually significant at .05 level. Variable 16, "frequency of rationalization of production", was significant only at .17 level, and variable 51, "rivalry among the producers in the industry", was not significant at all. As a substitute for variable 51, we estimated the same model substituting this variable by variable 53, "potential entry of new competitors". The results however were not altered and the coefficient of this variable was also insignificant (see ANNEX 4). Besides, when we estimated the above model eliminating these insignificant variables, the overall results had only a very small improvement in their level of significance.

[13] Ordered Logit models were also applied and gave very similar results.

Table IV.4

Estimation Results

Maximum Likelihood Estimates						
Log-Likelihood..............	-940.48					
Restricted (Slopes=0) Log-L.	-981.90					
Chi-Squared (7)............	82.847					
Significance Level..........	.00000					

Explanatory Variable	Coefficient	Standard Error	t-ratio	Prob. $\|t\| \geq x$	Mean of X	Std.Dev. of X
Constant	2.9824	.2639	11.304	.00000		
Exposed to the competition of imported goods (10)	-.12377	.2915E-01	-4.246	.00002	2.4592	1.4334
Share of exports in firms' total revenue (12)	.88394E-01	.1851E-01	4.777	.00000	2.4813	2.1758
Rationalization of production lines (16)	-.44882E-01	.3256E-01	-1.378	.16812	4.5357	1.2162
Substitution of own production for imported products (19)	-.10749	.3441E-01	-3.124	.00179	2.4558	1.3663
Purchase of technology abroad or licensing of products (24)	-.71755E-01	.3104E-01	-2.312	.02079	3.7500	1.4895
Better quality control (38)	-.12838	.3438E-01	-3.734	.00019	4.7143	1.1790
Rivalry among producers (51)	.86764E-02	.3381E-01	.257	.79745	4.3946	1.2358
MU(1)	.96768	.7672E-01	12.613	.00000		
MU(2)	1.6341	.8354E-01	19.561	.00000		
MU(3)	2.3939	.9210E-01	25.993	.00000		
MU(4)	3.2892	.1152	28.560	.00000		

Source: Author's calculations.

The predicted probabilities distribution of firms on their degree of preparedness for foreign competition, calculated as described in the methodological chapter, were fairly close to the actual probabilities as one can see in the table below.

Table IV.5

Predicted and Actual Probabilities:

Y=	Predicted Prob.	Actual Prob.
0	.055504	.06633
1	.210154	.21939
2	.250479	.23639
3	.272063	.25000
4	.166811	.16667
5	.044988	.06122

Source: Author's calculations.

The marginal effects the explanatory variables on the probability distribution of the degrees of preparedness for foreign competition are shown below.

Table IV.6

Matrix of Partial Effects:

	Explanatory Variables						
y	10	12	16	19	24	38	51
0	.138676E-01	-.990424E-02	.502886E-02	.120440E-01	.803995E-02	.143849E-01	-.972166E-03
1	.267223E-01	-.190850E-01	.969040E-02	.232082E-01	.154926E-01	.277190E-01	-.187332E-02
2	.874523E-02	-.624582E-02	.317131E-02	.759519E-02	.507016E-02	.907139E-02	-.613068E-03
3	-.134867E-01	.963218E-02	-.489073E-02	-.117131E-01	-.781910E-02	-.139897E-01	.945462E-03
4	-.241196E-01	.172261E-01	-.874655E-02	-.209477E-01	-.139836E-01	-.250191E-01	.169086E-02
5	-.117289E-01	.837679E-02	-.425330E-02	-.101865E-01	-.680001E-02	-.121664E-01	.822237E-03

Source: Author's calculations.

The table below shows what are the expected changes in the share of firms that would be on the upper half level, i.e., firms that are medium to very well prepared for foreign competition, with one unit increase in the value of each explanatory variable when holding all others explanatory variables constant at their mean levels. For example, with one unit increase in the average share of exports in firms' total revenue, the number of firms that would be on the upper half level, i.e., firms that are medium to very well prepared for foreign competition, would increase by 3.5 %, i.e. from 47.8% to 51.3%.

Table IV.7

Expected Changes in the Share of Firms Medium to Very Well Prepared to Face Foreign Competition:

Explanatory Variable	Expected Change (%)
Exposed to the competition of imported goods (10)	-4.9
Share of exports in firms' total revenue (12)	3.5
Substitution of own production for imported products (19)	-1.8
Rationalization of production lines (16)	-4.3
Purchase of technology abroad or licensing of products (24)	-2.9
Better quality control (38)	-5.1
Rivalry among producers (51)	.3

Source: Author's calculations.

The complete results for the three clusters and for the three industries that we estimated separately are shown in ANNEX 4. For all three clusters the hypothesis that all slopes of the nonconstant regressors are zero at .05 significance level is rejected. Moreover, for all the regressors that were significant, the coefficients had the expected signs. In cluster B, only variables 10 and 12 were significant at the .05 level, while in cluster C, variables 10 and 38 were significant at that level and variable 38 was significant at the .1 level.

In the industries results, only Electric Material and Communications had an overall significance level smaller than .05.

For that industry, the only variable that had a significant coefficient was with respect to the frequency of substitution of own production for imported products with the liberalization policy (variable 19).

The next table summarizes the individual significance level of coefficients of the regressors for each estimated equation. Based on these results, we can identify the clusters' and industries' specific characteristics by looking at which set of explanatory variables was significant in each case.

Table IV.8

Dimension 1: Determinants of Preparation for Foreign Competition

Regressors' Significance Level[a]

Explanatory Variable	All Firms	Cluster[b]			Industry[c]		
		A	B	C	Machinery	Electric & Communic. Equip.	Textiles
Exposed to the competition of imported goods (10)	(a)	(c)	(a)	(a)			
Share of exports in firms' total revenue (12)	a	c	a		b		
Rationalization of production lines (16)	(c)						
Subst. of own production for imported products (19)	(a)			(a)		(a)	(c)
Purchase of technology abroad on licensing of products (24)	(a)		(c)				(c)
Better quality control (38)	(a)	(c)		(a)			
Rivalry among producers (51)							
Overall significance level	a	a	a			a	c

a/ The parenthesis indicates when the coefficient has a negative sign. Levels of significance a, b, and c means that the regressor is significant at the .05, .10, and .20 level, respectively.
b/ Cluster A: Mining; Wood products; and Printing and publishing.
Cluster B: Metal products; Chemicals; and Plastic products.
Cluster C: Transportation equipment; Perfumes, soaps and candles; Clothing and footwear; and Food products.
c/ Industries 4, 5 and 15 are respectively Machinery; Electrical and communications equipment; and Textiles.
Source: Author's calculations.

IV.5 - Interpreting the Main Results

In the overall estimation and for all three clusters, the explanatory variable whether the firm is already "exposed to the competition of imported goods" (10) was significant in determining the preparedness for foreign competition. As we extensively discussed in section IV.2, partially due to the high levels of protection, most firms located in Brazil declared that they did not face strong competition from imported goods. The negative sign in this coefficient indicates that for a good number of firms, this protection from foreign competition in the past allowed them to be internationally competitive and prepared to face trade liberalization. Exceptions to this rule were the following three industries were the coefficients were insignificant: Electrical and communications equipment, Machinery, and Textiles. As shown in chapter I, in the case of the first two industries' the revealed competitive disadvantage (RICI < 1) observed in 1990 remained so through 1993. In the case of textiles, its competitive advantage that was already relatively small in 1990 (1.05), improved during 1991 and 1992, but suffered a significative deterioration in 1993 when it was almost one, i.e., the industry's exports could barely compensate for the imports of textiles products. Moreover, although Electrical and communications equipment and Textiles industries had high levels of protection during the past decade, this was not sufficient to make them more prepared to face international competition.

This experience tells us that import protection by itself does not guarantee the development of a country's competitive industry. The reasons for such failure can be a combination of several factors: expectations that protectionist barriers will not be eliminated as programmed, a credibility problem; lack of the necessary time to "catch up"; high costs of inputs and equipments due to trade barriers during the protection period; a domestic market not sufficiently large to attain ideal scales of production; difficulties to export; etc. Policy makers should take a broader view of all these possible factors affecting the prospects of an industry before defining any trade/industrial policy.

The "share of exports in firms' total revenue" (12) was significant in clusters A (Mining, Wood products, and Printing and publishing) and B (Metal products, Chemicals, and Plastic products), and in the Machinery industry. This indicates that, for these industries, export promotion policies can contribute for their preparation to face foreign competition in the domestic markets.

The explanatory variables representing the "adjustment options with liberalization policy" included in the final estimation, also indicate distinct patterns among industries. The explanatory variable "substitution of own production for imported goods with trade liberalization" (19) was significant in industries of cluster C (Transportation equipment, Perfumes, soaps and candles, Clothing and footwear, and Food products), and the Electric and communications equipment and Textiles industries. With the exception of transportation equipment where some industry subgroups are of high technology, such as aeronautic equipment, the industries of cluster C are predominantly constituted of more traditional types that have already attained a considerable degree of maturity in Brazil. For these industries, the perceived importance of substitution of own production for imported goods probably indicates the presence of market distortions caused by trade restrictions that, with the greater liberalization of the economy, will lead to greater specialization of the production lines of the above industries. Notwithstanding, in the case of high technology industries such as in the electric and communications equipment, one can not discard the possibility that this result could indicate the presence of some potentially successful lines of production that are still in an "undeveloped" stage and could be eliminated.

On the other hand, the "perceived increase in the frequency of purchase of foreign technology and/or products licensing" (24) was significant in cluster B (Metal products, Chemicals, and Plastic products) and also in Textiles. This is an indicator that these industries are the ones that most require international integration in the markets for technology. A science and technology policy and property rights regulations should look more carefully to the needs of these industries that currently most depend on international markets for technology in the determination of their degree of competitiveness. These policies could include the increase in domestic technological capabilities and easier access to the international markets of technology.

Finally, when looking at the coefficients of "better quality control" (38), one observes that this explanatory variable was significant in clusters A and B showing that, in industries included in these clusters, trade liberalization should be preceded or at least accompanied with a strategy towards a greater rationalization of production, such as better quality control, better management of stock and better product. This would have a significant effect in improving the preparedness for foreign competition with the trade liberalization of these industries.

IV.6 - Summing Up

This chapter identified several important determinants of a firm/industry preparation for foreign competition. The past trade barriers seem to have contributed for the preparation for foreign competition for a good number of domestic firms from several distinct sectors. However, these high levels of trade barriers of the past years also created several market distortions that, with the start of the trade liberalization policy, are already leading to important adjustments from the part of many firms. For the more traditional types of industry, a greater specialization of production lines seems to be required. For other industries, the improvement of the product quality is their main perceived current need. A careful management of the opening of the economy is required in order to avoid unnecessary economic losses.

We also identified the set of industries that, in order to be competitive in a more open economy, will need high technology inputs which in many cases means a better access to the international markets of technology. This will require special attention when defining science and technology policies to improve domestic technological capabilities and the country's property rights regulation. In the case of industries that produce high technology equipment, their situation is certainly even more delicate and the long run costs of loosing these industries should be seriously taken into account. In chapter VII, when analyzing the fourth dimension about the determinants of firms/industries' main sources of technology, we shall return to a deeper discussion of these issues.

Finally, for seven of the twenty industries surveyed, the participation in the foreign markets through exports was significantly important in determining their degree of preparation to face greater foreign competition in the domestic markets. With the fazing out of import barriers, some policies directed to export promotion would be important not only to improve domestic firms' preparedness to face a greater competition, but also in order to maintain a more equilibrated trade balance. Given the importance of exports in the determination of the degree of competitiveness of a firm/industry, in the next chapter we will investigate what are the main determinants of a firm/industry share of exports in its total revenues, and what could be a set of appropriate policies to increase such share.

V - DETERMINANTS OF EXPORTS SHARE IN TOTAL REVENUE

The second dimension to be analyzed in this study is in a certain sense a corollary of the previous one. There, we evaluated the importance of several firms' strategies and government policies in the determination of the degree of preparedness to face foreign competition. The share of a firm's exports in its total revenue was included as one of these determinants. In this chapter we will more directly investigate what makes a firm export.

In the Brazilian case, the opening of the economy should endeavor to maintain a more stabilized economy, together with new legislation increasing foreign investment opportunities, in order to generate a greater amount of foreign capital inflows compensating for a larger deficit in the current account during the adjustment period of the trade liberalization program. Moreover, the government could also attempt to maintain its trade accounts somewhat balanced in terms of its increases of imports and exports, hence the importance to answer the above question in order to determine which policies could lead to an increase in the share of exports in a firm/industry's total revenue.

As we discussed in chapter I, in 1990 the Collor administration started its policy by reducing import tariffs and administrative controls, but simultaneously it eliminated the ongoing system of incentives for exports such as exchange rate policy and fiscal and credit subsidies. With the change in the economic team at the beginning of 1992, those incentives were partially reestablished which, together with a stagnant economy, allowed the maintenance of increasing trade surpluses.[1] During the economic recovery of 1993 and 1994, the drops in trade surplus were compensated by increases in net foreign investments. Due to the consumption boom caused by the "Real" stabilization plan, implemented in mid-1994, and the maintenance of an overvalued real exchange rate, it seems that the trade balance tends to deteriorate even further and that foreign investment inflows alone will not be sufficient to compensate for such imbalance. A fall in reserves can be a temporary solution, but a strategy leading to the recovery of the trade balance should be considered as a better alternative than having to encounter a much more difficult adjustment as the one faced by Mexico since its crisis of December 1994.

The analysis of this second dimension will contribute to identify what are the conditions, if any, that lead to a greater share of exports in a firm/industry's total revenue allowing for a more thriving opening of the economy. Moreover, if our results in dimension 1 showing that exporting firms are the most prepared to face foreign competition is correct, the creation of conditions leading to the increase in exports would contribute to the improvement of the degree of firms' preparedness to face greater foreign competition in the domestic markets with the opening of the economy.

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[1] Some of the main exports incentives that were reintroduced in February 1992 are: exemption of taxes on industrialized products (IPI) for domestic raw materials used in exporting goods; wider and greater incentives on the Export Financing Program (Proex); and reduction on the bureaucracy of export and import operations. (Oliveira, 1992)

In the next section we will discuss our hypothesis with respect to the variables that affect the firms' share of exports in total revenues.

V.1 - Initial Hypothesis

- *Explanatory Variable 1 - Firm's location.* (5,55) (classified in ascending order of states/regions' Gross Industrial Product)

We would expect that firms located in the richer regions should be the ones with a greater share of exports in their total revenues, given the reduced costs associated with the acquisition of information, human capital, better infra-structure, and the closeness to the main suppliers and buyers. However, the exceptions to this rule are considerable. They are the cases where the location of the firm is determined by the availability of natural resources or, where past regional incentives were used in order to install industrial parks in poorer areas. Examples of these exceptions are the great number of firms of Electrical and communications equipment located in the "Zona Franca de Manaus" in the State of Amazonas, and the huge state enterprises, such as Petrobrás, with refinery plants located in the State of Bahia.

Two types of location classification will be tested separately. The first classification, variable 5, grouped the states into six groups based on the size of their economy measured by their share in total GDP. The second classification, variable 55, did the same with respect to the main geographic regions:

North, North-East, South-East, Mid-West, and South (see ANNEX 1 for the list of States included in each region).

- *Explanatory Variable 2 - Perceived need for adaptation after trade liberalization.* (14) (1-very weak, 6-very strong)

As a first impression, one would expect that firms that already export are the ones that would need less adaptation with the trade liberalization, i.e., a negative correlation. However, one should notice that exporting firms are also the ones most aware of the existence of potential international competitors and better informed about the required adjustments in order to confront them in the domestic markets. Moreover, as we discussed in chapter I, the major market for most firms is the domestic market. The average share of exports in total production for the manufacturing sector was of 9.2 percent in 1990, ranging from 0.5 percent in the printing and publishing and furniture industries to 27.5 percent in the tobacco products industry. Firms that participate in both domestic and foreign markets would probably be the most aware of the need of making adjustments in their lines of production directed to the domestic market. If that is the case, a positive correlation between these variables would be expected.

There are also some firms that do not export due to the fact that they have products that are not frequently traded internationally, if at all. If trade liberalization occurs, these firms will not need important adjustments due to the nontradable characteristics of their products, reinforcing the possibility of a positive correlation.

Due to the above reasons and the composition of firms in the survey, when estimating the model for the entire sample, we expect a positive coefficient of the explanatory variable "need of adaptation after liberalization", with respect to firm's share of exports in total revenue. When estimating the model for distinct industry subsamples, it will be interesting to verify whether this positive correlation is really the general rule.

- *Explanatory Variable 3 - Perceived importance of import restrictions of informatic goods on industry's modernization.*

  (29) (1-not important, 6-very important)

Among the products included in the category of informatic goods are equipments for industrial automation, magnetic disk drives, magnetic tape drives, floppy disks, and monitors. One would *a priori* expect that the greater the impediments for a firm's modernization due to import restrictions of informatic goods, the less competitive this firm would be, having a lower share of its revenues due to exports. But we believe that the same reasons that we have discussed with respect to the explanatory variable 2, "perceived needs for adaptation with trade liberalization", are also valid here: exporting firms are better informed of modernization needs for competing in an unprotected domestic market. This would lead to an expected positive correlation between these two variables. The importance of these import restrictions on firms' modernization shall vary from industry to industry. This fact will be identified when we estimate the model for subsamples of industries defined by the cluster analysis in section V.3.

- *Explanatory Variable 4 - Perceived obstacles to export.* (30-37) (1-not important, 6-very important)

The eight obstacles to export included in the survey were: exchange rate, financing of foreign sales, financing of production, credit insurance, special incentives, bureaucratic obstacles, harbor costs, and transportation costs.

Due to the methodology of the survey, we would expect to have a positive coefficient on all eight obstacles to export variables with respect to the share of exports on total revenues. The reason for this is the following: firms that do not export either produce nontradable goods or, because they do not export, they are unaware of the existent obstacles to do so. On the other hand, firms that produce traded goods and/or already exports are much more aware of these obstacles to export and would point it out in their responses.

- *Explanatory Variable 5 - Perceived market structure.* (49-54) (1-very low, 6-very high)

As in the previous chapter, the expected coefficient signs for the six indicators of market structure contained in the survey with respect to the share of exports in total revenue could be divided into two groups. We would expect negative coefficient signs with respect to suppliers' and buyers' market power as well as with respect to the potential entry of new competitors and imported goods. On the other hand, in general, we would expect that firms located in a more competitive market, when measured by the degree of rivalry among producers and the velocity of introduction of new products, would have a greater share of exports in their total revenues, i.e., a positive coefficient.

Following the methodological steps exposed in chapter II, we will apply in the next section principal components analysis to, whenever possible, combine correlated explanatory variables in order to specify the final explanatory variables to be included in the estimations of the ordered probit and logit models. Correlation analysis will also be used for a preliminary check of the initial hypothesis.

V.2 - Correlations and Principal Components Analysis

- *Explanatory Variable 1 - Firm's location.* (classified in ascending order of states (5) or regions' (55) Gross Industrial Product)

When calculating the sample correlations between location variables and share of exports in total revenues, we did not get the initially expected positive signs, although the negative correlations were relatively small: Corr (5,12)= -.05 and Corr (55,12)= -.08. This result could in part be explained by the presence of the already mentioned exceptions to this rule: a relative higher proportion of exporting firms that explore natural resources are in general located in the poorest states and regions, benefits from special government incentives to these regions, or direct public industrial investments in these areas. While in the richer states and regions there is a smooth distribution of firms with respect to their share of exports in total revenues, in the poorer areas firms are concentrated in the two extremes of the distribution. However, in order to verify its significance for specific industrial clusters, we maintained the firms' classification by regions (variable 55) in the estimation of the final equation. If the estimations show that for certain industries the regional location is important in determining their share of exports in total revenues, this is possibly an indication of the success of regional industrial policies such as the "Zona Franca de Manaus" and direct government investments. One could also mention here the activities of Brazilian development bank BNDES and regional development agencies such as SUDAM and SUDENE.[2]

- *Explanatory Variable 2 - Perceived need for adaptation after trade liberalization.* (14) (1-very weak, 6-very strong)

The sample correlation was positive as expected although not very strong (Corr(12,14)=.06). The analysis of the crosstabulation of the two variables presented below, shows that some of our initial suspicions seems to be correct: 70% of the firms that export from 0% to 5% of their total revenues declared that their

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[2] "Superintendência do Desenvolvimento da Amazônia" and "Superintendência do Desenvolvimento do Nordeste", respectively.

need for adjustments was small (in the lower half of the scale), possibly implying that their products are mainly nontradables. On the other hand, from firms that export more that 35% of their revenues, 75% declared that their need for adjustments was also small, indicating that they are capable to sell in the domestic market a competitive product.

Although from this global crosstabulation one cannot get industry specific relations, this variable will be maintained in the final estimations where industries and clusters will also be estimated separately. In these cases, firms where the perceived need for adaptation after trade liberalization have a significant and positive correlation with respect to the size of their share of exports in total revenues, are the ones that probably will adjust the fastest. However, this would only be the case if the necessary conditions for such adaptations exist, such as financial credits for investments and easier access to imports of equipments and inputs from international markets.

Table V.1

Crosstabulation of "Share of exports in its total revenues" (12) and "Need for adaptation after trade liberalization" (14)[a/]

Share of Exports in Total Revenue (%)	Scale of Perceived Need for Adaptation						Row Total
	1	2	3	4	5	6	
0 to 5	60 17.4	65 18.9	116 33.7	74 21.5	22 6.4	7 2.0	344 53.1
6 to 10	9 9.2	15 15.3	33 33.7	28 28.6	12 12.2	1 1.0	98 15.1
11 to 15	3 5.1	11 18.6	24 40.7	12 20.3	7 11.9	2 3.4	59 9.1
16 to 20	1 4.2	5 20.8	4 16.7	8 33.3	6 25.0	0 0	24 3.7
21 to 25	4 12.1	5 15.2	12 36.4	6 18.2	8 18.2	0 0	33 5.1
26 to 30	3 11.1	5 18.5	8 29.6	7 25.9	3 18.2	1 3.7	27 4.2
31 to 35	0 0	5 45.5	0 0	4 36.4	1 9.1	1 9.1	11 1.7
More than 35	7 13.5	10 19.2	22 42.3	9 17.3	3 5.8	1 1.9	52 8.0
Column Total	87 13.4	121 18.7	219 33.8	219 33.8	148 22.8	60 9.3	648 100.0

a/ For each cell, the first line is the absolute frequency and the second line is the percentage based on row frequency.
Source: Author's calculations.

- *Explanatory Variable 3 - Perceived importance of import restrictions of informatic goods on industry's modernization.* (29) (1-not important, 6-very important)

The sample correlation between perceived importance of import restrictions of informatic goods on industry's modernization and share of exports was of .16, i.e., a positive correlation as initially expected. More than three quarters of firms with an export share in their total revenues greater than 30% declared that they faced medium to very important import restrictions of informatic goods on industry's modernization (i.e., answers from 4 to 6). With the liberalization of informatic goods we would expect that the industries for which this coefficient is most significant will be the first ones to react and to benefit from the improvement of their competitiveness in external markets.

- *Explanatory Variable 4 - Perceived obstacles to export.* (30-37)

(1-not important, 6-very important)

The eight obstacles to export contained in the survey were combined in three groups as follows:

Group i:
Exchange rate. (30)

Group ii:
Financing to foreign sales. (31)
Financing of production. (32)
Credit insurance. (36)
Especial incentives. (37)

Group iii:
Harbor costs. (34)
Bureaucratic obstacles. (33)
Transportation costs. (35)

Principal components analysis (see ANNEX 2) shows that all eight variables have a positive and similar coefficient in the first principal component, which alone explains 45.8 % of the variability. However, when one looks at the second and third principal components, the above group division seems appropriate.

All sample correlations of obstacles to export variables have positive signs as initially expected. For each of the above defined groups we selected the variable with the highest sample correlation to be the group's representative. Here again, this procedure was preferred to the summation of their values or any other method of aggregation, since the estimated coefficients would not be very meaningful. The representative variables, all expected to have a positive coefficient sign, are Exchange rate (30), Financing to foreign sales (31), and Harbor costs (34). By identifying which obstacles most affect the share of exports in total revenues in each industry, efforts to reduce these obstacles can be better handled.

- *Explanatory Variable 5 - Perceived market structure*. (1-very low, 6-very high)

The six types of competitive forces included in the survey in order to characterize the industry market structure are the following:

Suppliers' market power. (49)
Buyers' market power. (50)
Rivalry among producers in the industry. (51)
Velocity of introduction of new products. (52)
Potential entry of new competitors. (53)
Potential entry of imported goods. (54)

Principal components analysis were already analyzed in chapter IV. Here, however, sample correlations of each market structure variable with respect to export shares do not always corresponds to our initial expectations. Signs are as expected and significant for variable "Suppliers' market power" (49) and as expected but not significant for variable "Potential entry of new competitors" (53). They are incorrect and nonsignificant for variables 51,52, and 54. In the case of variable 50, "Buyer's market power", there is a small positive correlation of .07, which also was not initially expected.[3] Given the above statistical analysis, we have chosen to include the variable "suppliers' market power" (49) as the representative variable of this group of explanatory variables.

In this section, we selected the final explanatory variables to be included in the model. As in the previous chapter, before the estimation of the model for the entire data set, by applying cluster analysis, we will look whether we can identify some similar patterns among industries in the responses of the selected variables defined above that could be analyzed as separate subsamples of the survey's data.

V.3 - Cluster Analysis: Identifying Similar Patterns Among Industries

The second dimension of the study that is analyzed in this chapter investigates what are the main determinants of a firm/industry share of exports in its total revenues.

The explanatory variables, selected in the previous section by correlation and principal components analysis, to be included in

[3] In fact, this positive sign makes sense in certain markets for commodities that are mainly produced for export, and where there exists a few number of traders that control the international markets. This is particularly observed in the case of agriculture commodities.

the model are the following:

1 - Firm's location by Region. (55)

2 - Need for adaptation after trade liberalization. (14)

3 - Importance of import restrictions of informatic goods on industry's modernization. (29)

4 - Obstacles to export: Exchange rate. (30)

5 - Obstacles to export: Financing to foreign sales. (31)

6 - Obstacles to export: Harbor costs. (34)

7 - Suppliers' market power. (49)

The results of clustering these variables by seeded method can be found in ANNEX 3. Applying the same methodology as in the previous chapter, we defined four groups of industries that were very close in their response pattern. They are the following:

Cluster A: Mining (Ind.# 1)
Pharmaceutical and veterinary products (Ind.# 12)
Printing and publishing (Ind.# 20)

Cluster B: Metal products (Ind.# 3)
Chemicals (Ind.# 11)
Clothing and footwear (Ind.# 16)

Cluster C: Machinery (Ind.# 4)
Paper products (Ind.# 8)
Rubber product (Ind.# 9)
Textiles (Ind.# 15)

Cluster D: Electrical and communications equip. (Ind.# 5)
Wood products (Ind.# 7)
Leather products (Ind.# 10)
Perfumes, soaps and candles (Ind.# 13)
Plastic products (Ind.# 14)
Food products (Ind.# 17)

Since the clusters defined in Dimensions 1 and 2 were not identical, in order to make comparisons of the results, we also estimated the equations for the clusters and industries defined in Dimension 1 analyzed in the previous chapter. Here, these clusters will be denominated clusters E, F, and G representing respectively clusters A, B, and C of Dimension 1.

In the next section, the results of estimations of the ordered probit and logit models for all firms and the selected clusters and industries will be presented.

V.4 - Results of the Estimations of the Ordered Probit and Logit Models

The results of the estimation of the ordered probit model for the entire sample suggest that all the included determinants of a firm competitiveness were significant and with the expected signs. In the estimation of the models, we grouped the dependent variable "Average share of exports in total revenue" in five groups as follows.

Table V.2

Average share of exports in total revenue

Group	Percentage Range
00	0 to 5
01	6 to 15
02	16 to 25
03	25 to 35
04	More than 35

The results of the ordered probit model estimated with all firms of the survey can be found below. Given the existence of some omitted responses the sample size was of 574 firms.

The signs of the coefficients were the ones expected. The hypothesis that all slopes of the nonconstant regressors are zero at .0001 significance level is rejected. All regressors were individually significant at .05 level, except "Importance of import restrictions of informatic goods on industry's modernization" (29) that was significant at .16 level.

Table V.3

Estimation Results

Maximum Likelihood Estimates
Log-Likelihood.............. -699.01
Restricted (Slopes=0) Log-L. -740.62
Chi-Squared (7)............ 83.219
Significance Level.......... .00000

Explanatory Variable	Coefficient	Standard Error	t-ratio	Prob. |t|≥x	Mean of X	Std.Dev. of X
Constant	-2.0924	.7014	-2.983	.00285		
Firm's location by Region (55)	-.22571	.1092	-2.068	.03867	3.5645	.72492
Suppliers' market power (49)	-.21454	.6741E-01	-3.183	.00146	4.5348	1.1910
Importance of import restrictions of informatic goods on industry's modernization (29)	.85908E-01	.6093E-01	1.410	.15855	4.1359	1.4359
Need for adaptation after trade liberalization (14)	.16749	.7198E-01	2.327	.01997	3.0174	1.2005
Obstacles to export: Exchange rate (30)	.28550	.6616E-01	4.315	.00002	4.5261	1.4260
Obstacles to export: Financing of foreign sales (31)	.18839	.5747E-01	3.278	.00105	4.2073	1.5599
Obstacles to export: Harbor costs (34)	.17246	.7019E-01	2.457	.01401	5.0052	1.3722
MU(1)	1.2359	.9581E-01	12.900	.00000		
MU(2)	1.9064	.1239	15.390	.00000		
MU(3)	2.6083	.1650	15.806	.00000		

Source: Author's calculations.

The predicted probabilities distribution of firms on their export shares on total revenue, calculated as described in the methodological chapter, were pretty close to the actual probabilities as one can see in the table below.

Table V.4

Predicted and Actual Probabilities:

Y=	Predicted Prob.	Actual Prob.
0	.515274	.51220
1	.270051	.24913
2	.092014	.09408
3	.057861	.06446
4	.064800	.08014

Source: Author's calculations.

The marginal effects of the explanatory variables on the probability distribution of the export shares are shown below.

Table V.5

Matrix of Partial Effects:

	Explanatory Variables						
y	55	14	29	30	31	34	49
0	.563748E-01	-.418329E-01	-.214569E-01	-.713080E-01	-.470523E-01	-.430741E-01	.535845E-01
1	-.183224E-01	.135961E-01	.697373E-02	.231758E-01	.152925E-01	.139995E-01	-.174155E-01
2	-.137625E-01	.102125E-01	.523819E-02	.174081E-01	.114867E-01	.105155E-01	-.130814E-01
3	-.106116E-01	.787436E-02	.403892E-02	.134226E-01	.885683E-02	.810800E-02	-.100864E-01
4	-.136783E-01	.101499E-01	.520611E-02	.173015E-01	.114163E-01	.104511E-01	-.130012E-01

Source: Author's calculations.

Based on the matrix of partial effects, the table below shows what are the changes in the expected participation of firms with export shares on total revenue of 16% or greater, with one unit increase in the value of each explanatory variable when holding all others explanatory variables constant at their mean levels. Here, however one can have two distinct types of interpretation given the methodology of the survey. First, for example, with one unit increase in the average opinion with respect to suppliers' market power, the participation of firms with export shares in total revenue of 16% or more, would decrease by 3.6 percentage points, i.e. from 24.1% to 20.5%. The same type of interpretation is valid for the location variable.

The interpretation of expected changes on export shares due to changes in variables such as the importance of import restrictions of informatic goods on industry's modernization, the need for adaptation after trade liberalization, and obstacles to export is distinct and not so straightforward. For example, it would be incorrect to say that one unit increase in the level of an obstacle to export would raise the firms' average export share. Here the values of the expected changes are indicators of the awareness of the relevance of these obstacles on firms' exports. It will only tell the relative degree of importance of each variable. One can say, for example, that for the sample as a whole exchange rate problems are more important than harbor costs, as a barrier to more exports.

Table V.6

Expected Changes in the Share of Firms with a Share of Exports in Total Revenues of 16% or More:

Explanatory Variable	Expected Change (%)
Firm's location by Region (55)	-3.8
Suppliers' market power (49)	-3.6
Importance of import restrictions of informatic goods on industry's modernization (29)	1.4
Need for adaptation after trade liberalization (14)	2.8
Obstacles to export: Exchange rate (30)	4.8
Obstacles to export: Financing to foreign sales (31)	3.2
Obstacles to export: Harbor costs (34)	2.9

Source: Author's calculations.

The complete results of the estimations for the selected clusters and industries are shown in ANNEX 4. For all clusters the hypothesis that all slopes of the nonconstant regressors are zero at .05 significance level is rejected.[3] In the industries results, Textiles was not significant, and Machinery and Electrical and communications equipment industries had an overall significance level of .09 and .01, respectively. Moreover, for all the regressors that were significant, the coefficients had the expected signs.

The table below summarizes the individual significance level of the explanatory variable coefficients for each estimated equation. Based on these results, one can identify the clusters' and industries' specific characteristics by looking at which set of explanatory variables was significant in each case.

[3] The only exception is cluster C that is significant at .06 level.

Table V.7

Dimension 2: Determinants of Share of Exports in Total Revenue

Regressors' Significance Level[a]

Explanatory Variable	All Firms	Cluster[b]							Industry[c]		
		A	B	C	D	E	F	G	4	5	15
Firm's location by region (55)	(a)				(a)			(a)			
Suppliers' market power (49)	(a)	(b)	(a)			(b)	(a)	(c)	(c)		
Importance of import restrictions of informatic goods on industry's modernization (29)	c	c						c		b	
Need for adaptation after trade liberalization (14)	a		b				a	b	c		
Obstacles to export: Exchange rate (30)	a		a	b	a		a			c	c
Obstacles to export: Financing to foreign sales (31)	a		a	a	a		c	c		c	
Obstacles to export: Harbor costs (34)	a							b			
Overall significance level	a	a	a	b	a	a	a	a	b	a	

a/ The parenthesis indicates when the coefficient has a negative sign. Levels of significance a, b, and c means that the regressor is significant at the .05, .10, and .20 level, respectively.
b/ Cluster A: Mining; Pharmaceutical and veterinary products; and Printing and publishing.
Cluster B: Metal products; Chemicals; and Clothing and footwear.
Cluster C: Machinery; Paper products; Rubber product; and Textiles.
Cluster D: Electrical and communications equipment; Wood products; Leather products; Perfumes, soaps and candles; Plastic products; and Food products.
Cluster E: Mining; Wood products; and Printing and publishing.(same industries as cluster A of Dimension 1)
Cluster F: Metal products, Chemicals; and Plastic products.(same industries as cluster B of Dimension 1)
Cluster G: Transportation equipment; Perfumes, soaps and candles; Clothing and footwear; and Food products. (same industries as cluster C of Dimension 1)
c/ Industries 4, 5 and 15 are respectively Machinery; Electrical and communications equipment; and Textiles.
Source: Author's calculations.

V.5 - Interpreting the Main Results

The negative effect of the explanatory variable "Location by region" (55) was significant in explaining the shares of exports in firms' total revenues for clusters D (Electrical and communications equipment, Wood, Leather, Perfumes, Plastic, and Food products) and G (Transportation, Perfume, Clothing, and Food products). It seems that, at least for some of these industries, regional incentives and government direct investment could have been an important factor in the determination of their location. These incentives, such as exemptions of import tariffs on industrial inputs, subsidized credits, reduced the costs of production, making those firms more competitive in foreign markets. Whether these policies can be justified from a broader welfare perspective is a question that is not addressed in this study.

For nine of the surveyed industries, the explanatory variable "Suppliers' market power" (49) was significant. They are the Machinery, Mining, Pharmaceutical, Printing and publishing, Metals, Chemicals, Clothing, Wood, and Plastics industries. A reduction of suppliers' market power that for some industries could be obtained by increasing the level of competition in these markets through, for example, trade liberalization itself, would improve the share of exports in the total revenues of these industries.

The explanatory variable "Importance of import restrictions of informatic goods on industry's modernization" (29) was significant in Mining, Pharmaceutical and veterinary products, Printing and publishing, Transportation equipment, Perfumes, soaps and candles, Clothing and footwear, Food products, and Electrical and communications equipment (which includes informatic goods) industries. Firms located in these industries seem to be the ones most aware of the existence of potential international competitors and better informed about the required technological needs in order to compete in international markets. With the liberalization of informatic goods, these firms should be among the first ones to react and to benefit from the improvement of their competitiveness in external markets.

As we discussed in chapter I, in the last four years there have been significant productivity gains in the case of electrical and communications equipment, transport equipment, Food products, mining, and Perfumes, soaps and candles industries. In the first three industries there also was a fall in unit labor costs, and prices in these industries have grown below the manufacturing industry average between 1990 and 1994. The Pharmaceutical and Clothing and footwear industries, however, have shown insignificant productivity gains and the latter also showed well above total manufacturing industry average unit labor cost and product prices increases. In the Pharmaceutical industry this is in good part explained by the still undefined property rights regime for pharmaceutical products, maintaining firms in this industry under a non tariff barrier type of protection.

The explanatory variable "Need for adaptation after trade liberalization" (14) was significant in Metal products, Chemicals, Clothing and footwear, Plastic products, Transportation equipment, Perfumes, soaps and candles, and Food products industries indicating that for these industries the perceived need for adaptation after trade liberalization have a significant and positive correlation with respect to the size of their share of exports in total revenues. These industries are the ones that probably will adjust the fastest to the opening of the economy if the necessary conditions exist, such as easier imports of equipments. As described in the first chapter, there has been an increase in imports of modern equipments, and all the industries mentioned above have increased their share of exports in total production since 1990. Moreover, apart from the industries already mentioned in the previous paragraph, in the last four years, Metal products, Chemicals, and Plastic products industries, also showed significant increases in productivity, falling unit labor costs, and in the case of the last two industries prices have increased at a smaller rate than average manufacturing industries price increase.

Finally, two of the explanatory variables representing obstacles to export, "Exchange rate" (30) and "Financing of foreign sales" (31) were significant in all clusters except A and E. This shows how each of these obstacles affects the shares of exports in total revenue of the firms included in these clusters. As we saw in chapter I, strong real exchange rate fluctuations and real overvaluation during the past two years, continues to be a serious problem that if reversed could lead to a significant increase in industrial exports. The third obstacle, "Harbor costs" (34), although significant at the all firms level, at the clusters level, showed to be of more importance for firms in Transportation equipment, Perfumes, soaps and candles, Clothing and footwear, and Food products industries. These three obstacles to export should be among the first that should be solved in order to foster exports and benefiting in particular the industries mentioned above that need it most.

V.6 - Summing Up

In dimension 1 discussed in the previous chapter, the share of a firm's exports in its total revenue was considered as one of the determinants of the degree of preparedness to face foreign competition. In this chapter we analyzed what are the conditions, if any, that lead to a greater share of exports in a firm/industry's total revenue. This would contribute to the improvement of the degree of firms' preparedness to face foreign competition in the domestic markets and allow a more successful opening of the economy.

In analyzing certain economic conditions we were able to identify for which industries these conditions were the most effective in improving the share of exports in firms' total revenues. Among these economic conditions were regional incentives and government direct investment in less developed areas of the country, policies leading to a reduction on suppliers' market power, the liberalization of imports of informatic goods, the availability of financial credits, easier imports from international markets, a more stable and realistic real exchange rate, and the reduction of main obstacles to export, in particular harbor costs.

In the next chapter, we will look at the third dimension to be analyzed in this study. We are concerned with what are the determinants of distinct adjustment options with liberalization policy within firms and industries. This analysis will contribute to the understanding of the current and future profile of the Brazilian industry facing the opening of its economy.

VI - DETERMINANTS OF ADJUSTMENT OPTIONS WITH TRADE LIBERALIZATION POLICY

In this chapter, we will try to establish the determinants of adjustment options that could be undertaken by each firm/industry in reaction to trade liberalization. These adjustments are not only an indicator of their main current deficiencies with the liberalization of the economy, but will also give a better idea of their future situation in terms of capital ownership, degree of vertical integration, diversification of production, and capital and human resources investments. This information could be helpful in determining the pace of trade liberalization and other regulatory and industrial policies that could affect the future profile of Brazilian industry.

As a distinction from the analysis of the previous dimensions, instead of having a single dependent variable, there are thirteen adjustment options considered in the survey. Each firm responded what was the degree of importance of each adjustment option in a scale from 1 to 6.

To estimate the equations for all thirteen adjustment options would have been a strenuous work that would have ended up obscuring instead of clarifying things. For this reason, looking at the results of principal components analysis, which methodology was described in chapter II and the main results can be found in ANNEX 2, we were able to arrange the adjustment options by common patterns into five groups as follows:

Group i:
Substitution of own production for imported products (19)
Reduction of production line diversification (20)
Increase in imports of components (18)
Reduction of degree of vertical integration (17)

Group ii:
Rationalization of production lines (16)
Extension of human resources training (25)
Creation/expansion of quality control programs (26)

Group iii:
Purchase of foreign technology/Products licensing (24)
Increase in technology investments (23)
Acquisition of new machinery and equipments (15)

Group iv:
Association with multinational enterprises (21)
Mergers and consolidations (22)

Group v:
Renegotiation of suppliers prices (27)

For each of the above defined groups we selected one representative variable for the estimations of the probit and logit models. They were the following: 1 - "substitution of own production for imported products" (19); 2 - "rationalization of production lines" (16); 3 - "purchase of foreign technology/Products licensing" (24); and 4 - "association with multinational enterprises" (21), for groups i to iv, respectively. Group v was not included in the final estimations due to the fact that, at the time of the survey, renegotiations of suppliers prices was a monthly if not a daily issue in most of the Brazilian firms, making it impossible to isolate the specific effects caused by the current trade liberalization. The procedure of selecting a representative variable for each group was preferred to the summation of their values or any other method of aggregation, since the estimated coefficients would not be very meaningful.

1 - The perceived frequency of "substitution of own production for imported products in the industry with the liberalization policy" (19) could be an indicator of the degree of substitutability of a firm's products as well as an indicator of the presence of market distortions. Some firms/industries have products that are less likely to be substituted due to costs of transportation, different cultures, different climates, or simply because they are nontradable types of goods. As we discussed in chapter IV, the perceived importance of substitution of own production for imported goods probably indicates the presence of market distortions caused by trade restrictions that, with the greater liberalization of the economy, will lead to a reduction in firms' degree of diversification and/or vertical integration. While in some cases one could be looking at a firm that is becoming globally more efficient, in other cases it could be the indication of the elimination of an "infant industry" that has not yet attained its "maturity" and, in some cases, would have never attained it anyway. Which of the above interpretations is the most adequate depends on the specific characteristics of each industry and production line as we will attempt to see in this chapter.

2 - The perceived frequency of "rationalization of production lines in the industry with the liberalization policy" (16) is an indicator of the gap in efficiency of production that was possible given the past protectionist regime.

3 - The perceived increase in the frequency of "purchase of

technology abroad and/or licensing of products in the industry with the liberalization policy" (24) indicates which industries depend most on world markets of technology, i.e., which are the industries that most seek to be internationally integrated in these markets in order to be competitive. This will be important when defining the country's property rights legislation.

4 - The perceived potential "association with multinational enterprises with the liberalization policy" (21) gives an idea of the future profile of the Brazilian industrial ownership composition. The possibility of association with multinationals is an indicator that although it is not possible, or at least not as interesting, for a firm to survive without such association, the firm has enough attractive resources to make an association instead of simply disappear.

A discussion of our initial hypothesis with respect to the relationship between the selected adjustment options and the explanatory variables follows.

VI.1 - Initial Hypothesis

- *Explanatory Variable 1 - Share of exports in firms' total revenues.* (12) (see scale in ANNEX 1)

We would expect that the greater the share of exports in a firm's total revenue the smaller the frequency of adjustments required in these production lines with the trade liberalization, since the firm would already be closer to the international standards in terms of the adopted technology of production, firm's degree of vertical integration and product quality.[1] One exception is with respect to the frequency of purchase of foreign technology and product licensing (24). In this case, we expect a positive coefficient, since firms that export more are also the ones that would be more informed of international technological advances that could increase their domestic and foreign competitiveness which was until recently constrained by import restrictions. In the final estimations, it will be interesting to see the distinct degrees of importance of the alternative adjustment options for each specific industry.

- *Explanatory Variable 2 - Perceived velocity of the current trade liberalization.* (9) (1-very slow, 6-very fast)

Firms that evaluate the ongoing trade liberalization to be too fast are the ones that probably have the need for a greater amount of adjustments in order to cope with the new economic environment. We expect a positive sign with respect to all adjustment options.

- *Explanatory Variable 3 - Exposure to foreign competition.* (10) (1-very low, 6-very high)

If firms, even at high levels of protection of the economy, are still facing foreign competition in the domestic markets, this

[1] In the case of industries where firms have some products that are exclusively directed to the domestic market, with trade liberalization, these production lines would probaly need some adjustments what could affect our expected negative correlation.

is probably an indicator that these firms have a considerable technological gap in their production lines.[2] Since, as shown in chapters I and IV, Brazilian protection levels were still considerably high at the time of this survey, we would expect a positive coefficient of this explanatory variable with respect to frequency of all adjustment options. Here again, the estimation of the expected marginal effects for each specific cluster of industries could give an indicator of the magnitude of this technological gap in each of them.

- *Explanatory Variable 4 - Evaluation of current informatic goods' import restrictions on industry's modernization.* (29) (1-very weak, 6-very strong)

The firms that currently consider that they suffer most from import restrictions for their modernization are the ones that will probably undertake more frequent adjustments after trade liberalization, i.e., a positive correlation between these variables is expected.

- *Explanatory Variable 5 - Perceived need to rationalize the production process.* (38-43)

Here, we also expect a positive correlation on all types of rationalization of production included in the survey, since the firms that currently need most improvements in their production

[2] By technological gap, we mean differences in product quality, types of product, as well as in costs of production.

process are certainly the ones that will need more adjustments with the trade liberalization.

• *Explanatory Variable 6 - Sources of firms' technology.* (44-48)

The table below shows the expected coefficient signs for the four adjustment options representatives with respect to the five sources of technology. We placed a question mark in the cases where we had no specific expectations on the signs of the coefficients. The main reasons behind these expected signs are the following.

Table VI.1

Expected Coefficients Signs on Sources of Technology Regressors

Dependent Variables	Expected Coefficient Sign Per Source of Technology				
	Firms' Own Tech.	Sup./Buyers	Univ./Res. Inst.	Eng. Firm	Foreign Tech
Substitution of own production for for imported products (19)	-	-	-	?	+
Rationalization of production lines (16)	+	+	+	+	+
Purchase of foreign technology /Products licensing (24)	+	+	+	+	+
Association with multinational enterprises (21)	+	+	+	?	+

With trade liberalization, pressures for better quality and lower costs will certainly increase, requiring certain technological improvements if firms intend to maintain themselves competitive. *A priori*, we would expect that any increase in importance of any source of technology would tend to increase the frequency of all types of adjustments. However, there are some exceptions to this rule.[3] We do not expect, for example, that a firm that increases the importance of its own technology development, would necessarily have to increase the substitution of its own production for imported goods (19). The same should be true in the cases of suppliers/buyers and university/research institute sources of technology. In the case of engineering firms' source of technology, we do not have any *a priori* expectations on the signs of the coefficients of this variable with respect to dependent variables substitution of own production for imported products (19) and association with multinational enterprises (21). Here again, the distinct signs of these coefficients at the industry level will show their specific characteristics.

- *Explanatory Variable 7 - Perceived market structure.* (49-54) (1-very low, 6-very high)

The six competitive forces included in the survey are the following:

Suppliers market power (49)
Buyers market power (50)
Rivalry among producers in your industry (51)
Velocity of introduction of new products (52)
Potential entry of new competitors (53)
Potential entry of imported goods (54)

As mentioned in chapter IV, the first five forces corresponds

[3] Trade liberalization could also change the relative importance of each technological source. In chapter VII, we will discuss the determinants of firm/industry's main source of technology.

to Michael E. Porters' scheme of industry structural analysis.[4] The last variable, potential entry of imported goods, was introduced to highlight firms' perceptions of the potential effects of the trade liberalization program.

We would expect that the more competitive is an industrial market, when measured by variables 51 to 54, the greater the need for firms' adjustments. The apparent incoherence of this expectation can be explained as follows. The trade liberalization will allow firms to "import adjustments" that could not have been done before, such as new machinery and equipment and product licensing. Firms in more competitive markets tend to be much more aware of the need and the existence of these new opportunities and they will probably be facing even higher degrees of competition after the trade liberalization.

We also expect a positive coefficient with respect to the increase of market power of suppliers and buyers since they would have an even greater influence on the firms' production characteristics.

- *Explanatory Variable 8 - Firm's location.* (5,55)

We would expect that all types of adjustments would be more frequent in the richer than in the poorer states/regions of the country. Reasons for that are similar to the ones of the market structure variables where the easier access to information plays an important role. The two types of location classification, per state

[4] Porter (1985).

groups and per region, will be tested separately.[5]

Let us turn to correlations and principal components analysis in order to select the explanatory variables to be kept in the estimations of the probit and logit models.

VI.2 - Correlations and Principal Components Analysis

- *Explanatory Variable 1 - Share of exports in firms' total revenues.* (12)

At the overall level we did not find any strong correlation between adjustment options and the share of exports in firms' total revenues. None of these correlations was significant at the .01 level. It only had a small positive coefficient (Corr(12,24)=.063), significant at .2 level, with respect to purchase of foreign technology/products licensing (24). However, we kept this variable in the final model in order to verify whether they could be significant for specific industries. This will be possible by estimating the model for industry subsamples to be defined by the cluster analysis.

- *Explanatory Variable 2 - Velocity of trade liberalization.* (9)

All dependent variables, except association with multinationals (21), had significant positive correlation coefficients as expected: firms that evaluate the ongoing trade liberalization to be too fast are the ones that have the need for

[5] For the location classification, see ANNEX 1.

a greater amount of adjustments in order to cope with the new economic environment. The reason for the nonsignificant sign with respect to association with multinationals, could be due to the fact that this alternative is not always available. With the industry level estimations one will see where it is more frequent.

- *Explanatory Variable 3 - Exposure to foreign competition.* (10)

The overall correlations had the expected signs and were significant at .05 level, with the exception of rationalization of production lines (16), significant only at the .25 level. This corroborates the hypothesis that firms that, even with the high levels of protection of the economy, are still facing foreign competition in the domestic markets, have a considerable technological gap in their production lines.

- *Explanatory Variable 4 - Evaluation of current informatic goods' import restrictions on industry's modernization.* (29)

The overall correlations had the expected signs and were significant at .02 level, with the exception of substitution of own production for imported products (19), significant only at the .3 level. It indicates that firms that currently consider that they suffer most from import restrictions for their modernization are the ones that shall undertake more frequent adjustments after trade liberalization.

- *Explanatory Variable 5 - Perceived needs to rationalize the production process.* (38-43)

The correlations between rationalization of production variables and adjustment options variables were all positive as expected, supporting the hypothesis that firms that currently need most improvements in their production process are the ones that will need more adjustments with the trade liberalization. As the representative variable we chose variable 40, a better product, which is one of the firms' main concerns with the potential entrance of new foreign competitors.

- *Explanatory Variable 6 - Sources of firms' technology.* (44-48)

All the expected signs were confirmed with the correlation analysis, with the exception of the correlation between university/research institute and rationalization of production lines where the correlation was insignificant. In the case of engineering firms' source of technology, there were two significant results for which we had no *a priori* expectations: the greater the importance of engineering firms' source of technology, the smaller the tendency for substitution of own production for imported goods and the greater the tendency for association with multinationals.

Due to the limitations on the maximum number of explanatory variables to be included in the final model, three sources of technology were selected: firms' own technology, engineering firms, and foreign technology. These were the variables with the strongest correlations with the dependent variables and also consistent with principal components analysis method of selection (see ANNEX 2).

- *Explanatory Variable 7 - Perceived market structure.* (49-54)

Principal components analysis indicates that all six variables have positive coefficients in the first principal component, although the first two variables, suppliers' and buyers' market power, had smaller coefficients than the other four (see ANNEX 2). As before, it would not be very meaningful to construct an index with those variables since the interpretation of its estimated coefficient would not tell very much in itself. We looked at the sample correlations in order to select the most appropriate representative variable for the perceived market structure.

The sample correlation coefficients of the market structure explanatory variables with respect to the adjustment options variables were significant and with the expected signs: the more competitive is an industrial market the greater the firms' adjustments with trade liberalization, due to its greater awareness of new opportunities and possible emergence of an even more competitive economic environment. The only exception was suppliers' market power (49) which was not significant in any of the cases. As the representative variable for market structure we included in the final model the potential entry of new competing products (53), the variable with the greatest correlation coefficients.

- *Explanatory Variable 8 - Firm's location.* (5,55)

Although the sample correlations between location variables and adjustment options had the expected coefficient signs they were small and not always significant. We decided to eliminate this variable from the final estimations.[6]

In this section, we selected the final explanatory variables to be included in the model. Before the estimation of the model for the entire data set, we will employ cluster analysis, in order to look whether one can identify similar patterns among industries in their responses on the importance of the four selected adjustment options.

VI.3 - Cluster Analysis: Identifying Similar Patterns Among Industries

The third dimension of this study that is analyzed here is concerned with the determinants of different adjustment options to the liberalization policy. In the beginning of this chapter, the following four adjustment options, i.e., the dependent variables for which the models will be estimated, were selected:

1 - Substitution of own production for imported products. (19)

2 - Rationalization of production lines. (16)

3 - Purchase of foreign technology/Products licensing. (24)

4 - Association with multinational enterprises. (21)

The explanatory variables, selected by correlation and

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[6] When this variable was included in my preliminary estimations of the logit and probit models, its coefficients were always insignificant.

principal components analysis, to be included in each of the above four cases are listed below.

1 - Share of exports in firm's total revenues. (12)

2 - Perceived velocity of trade liberalization. (9)

3 - Exposure to foreign competition. (10)

4 - Import restrictions on industry's modernization. (29)

5 - Rationalization of production: Better Product. (40)

6 - Firms' own technology development. (44)

7 - Engineering firms' technology development. (47)

8 - Foreign technology development. (48)

9 - Potential entry of new competitors. (53)

Given the fact that we have four distinct adjustment options, we decided to build the industry clusters as a function of their similarities in terms of their adjustment strategies. In ANNEX 3 one can find the results of clustering the adjustment options variables by the average method, already described in the methodological chapter. As before, we defined two groups of industries that were very close in their response pattern. They are the following:

Cluster A: Metal Products (Ind.# 3)
Machinery (Ind.# 4)
Electrical and communications equipment (Ind.# 5)
Transportation equipment (Ind.# 6)
Paper products (Ind.# 8)
Rubber product (Ind.# 9)
Leather products (Ind.# 10)
Chemicals (Ind.# 11)
Pharmaceutical and veterinary products (Ind.# 12)
Perfumes, soaps and candles (Ind.# 13)
Plastic products (Ind.# 14)
Beverages (Ind.# 18)

Cluster B: Textiles (Ind.# 15)
Clothing and footwear (Ind.# 16)

We also estimated the equations for the Food products industry (Ind.# 17), which was not included in any of the above clusters and has a sample large enough to allow its separate estimation.

In the next section, the results of the estimations of the ordered probit and logit models for all firms and for the selected clusters and industries will be presented.

VI.4 - Results of the Estimation of the Ordered Probit and Logit Models

One can find in the table below a summary of the results of the ordered logit model estimated with all firms of the survey for each of the selected adjustment options.[7] The hypothesis that all slopes of the nonconstant regressors are zero at .001 significance level is rejected for all estimations. The signs of the individually significant coefficients,i.e., a significance level of at least .2, were the ones expected. The firms' predicted probability distributions with respect to the frequency of adjustments options were fairly close to the actual probabilities. One can see the latter and the marginal effects of the explanatory variables on these probability distributions in ANNEX 4.

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[7] Similar results were obtained when estimating the ordered logit model. For the complete results of the estimations see ANNEX 4.

Table VI.2

Summary of the Results of the Ordered Logit Model Estimated for Adjustment Options

Explanatory Variable	Coefficients and Significance Level of Estimates[a]							
	Subst. of own production for imported products (19)		Rationalization of production lines (16)		Purchase of foreign tech./licensing (24)		Association with MNEs (21)	
Share of exports (12)	-.0446	(.211)	.0313	(.341)	.0104	(.773)	-.0091	(.786)
Velocity of trade liberalization (9)	.1618	(.019)	.2323	(.000)	.0398	(.557)	-.0818	(.216)
Exposure to foreign competition (10)	.2911	(.000)	.0024	(.968)	.0471	(.419)	.1468	(.008)
Import restrictions on industry's modernization (29)	.0668	(.207)	.1581	(.003)	.1752	(.000)	.0817	(.110)
Rationalization of production: Better Product (40)	.1430	(.036)	.2191	(.001)	.1977	(.002)	.1545	(.022)
Firms' own technology development (44)	-.07528	(.248)	.3328	(.000)	.0315	(.610)	.0102	(.871)
Engineering firms' technology development (47)	-.1901	(.000)	.0055	(.916)	-.0249	(.646)	.0631	(.249)
Foreign technology development (48)	.2704	(.000)	.0914	(.095)	.5082	(.000)	.2422	(.000)
Potential entry of new competitors (53)	.28652	(.000)	.1036	(.078)	.2165	(.000)	.2054	(.000)
Overall Significance Level	.000		.000		.000		.000	
Number of Observations	576		583		577		574	

a/ Significance levels in parenthesis.
Source: Author's own calculations.

The table below shows what are the predicted changes per adjustment option in the share of firms at the top half of the scale of frequency of adjustments, due to one unit increase in the value of each explanatory variable when holding all others explanatory variables constant at their mean levels. For example, with one unit increase in the average firms' opinion with respect to current exposure to foreign competition, the participation of firms that would substitute their own production for imported products frequently, i.e., answers form 4 to 6 in a scale from 1 to 6, would increase by 4.3 %.

Table VI.3

Predicted Changes per Adjustment Option in the Share of Firms at the Top Half in Terms of Adjustment's Frequency [a]

Explanatory Variable	Predicted Change in Each Adjustment Option (%)			
	Subst. of own production for imported products (19)	Rationalization of production lines(16) [b]	Purchase of foreign tech./licensing (24)	Association with MNEs (21)
Share of exports (12)	-.7	.8	.2	-.2
Velocity of trade liberalization (9)	2.4	5.6	.9	-1.9
Exposure to foreign competition (10)	4.3	.1	1.1	3.4
Import restrictions on industry's modernization (29)	.1	3.8	3.9	1.9
Rationalization of production: Better Product (40)	2.1	5.3	4.4	3.6
Firms' own technology development (44)	-1.1	8.1	.7	.2
Engineering firms' technology development (47)	-2.8	.1	-.6	1.5
Foreign technology development (48)	4.0	2.2	11.4	5.6
Potential entry of new competitors (53)	4.2	2.6	4.9	4.8

a/ Firms that consider the adjustment option at levels of 4, 5 and 6 in a scale of frequency of the adjustment from 1 to 6.
b/ Top tier only, i.e., firms that consider the adjustment option at levels of 5 and 6 in a scale of frequency of the adjustment from 1 to 6.
Source: Author's own calculations.

The complete results for the clusters and industries that we estimated separately are shown in ANNEX 4. The next table summarizes the individual significance level of the explanatory variable coefficients for each estimated equation. Based on these results, we can identify the clusters' and industries' specific characteristics by looking at the set of explanatory variables that was significant in each case.

Table VI.4

Dimension 3: Determinants of Adjustment Options with Liberalization Policy

Regressors' Significance Level [a]

Explanatory Variables	Subst. of own production for imported products (19)				Rationalization of production lines (16)				Purchase of foreign tech./licensing (24)				Association with MNEs (21)			
	All	A	B	F	All	A	B	F	All	A	B	F	All	A	B	F
Share of exports (12)			(c)									c			(c)	a
Velocity of trade liberalization (9)	a	b			a	a										
Exposure to foreign competition (10)	a	a	a	c									a	b	b	
Import restrictions on industry's modernization (29)	c				a	a			a	a			c	a		
Rationalization of production: Better Product (40)	a	a			a	a	b		a	a			a	a		
Firms' own technology development (44)		(a)			a	a	a									
Engineering firms' technology development (47)	(a)	(a)	a	c											a	
Foreign technology development (48)	a	a		c	b			b	a	a		a	a	a		a
Potential entry of new competitors (53)	a	a			b			c	a	a	c	b	a	a		a
Overall Significance Level	a	a	a	a	a	a	b	c	a	a		a	a	a	a	a

a/ The parenthesis indicates when the coefficient has a negative sign. Levels of significance a, b, and c means that the regressor is significant at the .05, .10, and .20 level, respectively.
Cluster A: Metal Products, Machinery, Electrical and communications equipment, Transportation equipment, Paper products, Rubber product, Leather products, Chemicals, Pharmaceutical and veterinary products, Perfumes, soaps and candles, Plastic products, and Beverages.
Cluster B: Textiles and Clothing and footwear.
F is the Food products industry.
Source: Author's own calculations.

VI.5 - Interpreting the Main Results

Based on the above table a number of interesting conclusions can be drawn. In the following paragraphs we will highlight some of them that we consider of particular importance in the current process of liberalization of the Brazilian economy.

For firms in cluster B (Textiles and Clothing and footwear), the greater their share of exports in their total revenues, the less they will require the substitution of own production for imported products or the association with multinational enterprises with trade liberalization.[8] On the other hand, a distinct pattern of integration with international markets is shown by the Food products industry. Here, firms with a greater share of exports are the ones that would increase the purchase of foreign technology and product licensing and the association with multinationals. The distinct strategic behavior of these two group of industries could be related to international factors, such as different final products marketing systems and access to modern equipments, as well as due to distinct domestic incentives. In the case of Textiles and Clothing and footwear industries, there is an international market for the first generation equipments that are required to remain competitive.[9] For certain products in the Food industry, brand names and a world wide marketing chain play a very important role making more natural the search for international allies and the purchase of foreign licensing.

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[8] In the textiles industry, only one fifth of the surveyed firms considered these two adjustment alternatives at the upper half level of the frequency of adjustments scale. In the clothing and footwear industry, none declared the need for substitution of own production for imported products and only 7.4% declared association with multinationals at the top half of the scale. These exceptions, as we will discuss later, are generally associated with firms that depend heavily of engineering firms' technology development.

[9] Between 1989 and 1994, US$2 billion was spent on acquiring international modern machinery in these industries. A similar amount has been spent on acquiring domestically-made equipment.

The explanatory variable velocity of trade liberalization, is an indicator of how much a firm is lagging behind in its required adjustments to face greater foreign competition in domestic markets. For firms in cluster A, where twelve types of industries were included, two types of adjustment options were significant with respect to this explanatory variable. First, the faster the velocity of trade liberalization perceived by a firm, the greater will be its effort to make the production lines more efficient. This result was also obtained by Braga and Willmore (1988) in their study based in a 1980 survey of Brazilian firms, where the probability of activities of rationalization of production lines increased with a reduction in trade barriers. Secondly, and a more interesting result, is the fact that the greater the velocity of trade liberalization declared by a firm, the more the firm would substitute its own production for imported products. This is an indicator that for firms in cluster A, a lower pace in trade liberalization could reduce the required share of the import content in the domestic production in order for these firms to maintain their competitiveness.

Firms that, even with the high levels of protection of the economy, were still exposed to foreign competition in the domestic markets declared that with trade liberalization, their adjustment options, i.e., their alternatives to face even greater competition, would be to substitute their own production for imported goods and to make associations with multinationals. These results were significant for both cluster A and B. For the food products industry the results were significant only with respect to substitution of own production for imported goods.

Import restrictions on industry's modernization had significant positive coefficients in the estimations of all four selected adjustment options. It was particularly significant in the twelve industries of cluster A, except with respect to substitution of own for imported products. This result shows how such restrictions were an impediment for the modernization of Brazilian manufacturing sector. As mentioned in chapter I, imports of capital goods more than doubled since 1991.

At the overall estimations, the greater the need for rationalization of production, here represented by the explanatory variable better product, the more frequent will be all kinds of adjustment options. This was also the case when looking exclusively to cluster A.

The three sources of technology included in the final estimations have some interesting results with respect to the adjustment options with trade liberalization. In cluster A, the greater the importance of firms' own technology or of engineering firms' technology, the less the firm would tend to substitute its own production for imported products. On the other hand, and this was also significant for the food products industry, the greater the importance of firms' foreign technology source, the greater would be the substitution of own production for imported products, the purchase of foreign technology/product licensing and association with multinationals. For Textiles and Clothing and footwear industries, cluster B, the greater the importance of engineering firms' source of technology, the more these firms will tend to substitute their own production for imported products and to associate with multinationals with the trade liberalization. This could be an indicator that either these engineering firms are no longer capable to fulfill alone the firms' technological requirements in a more competitive environment, or that the types of transactions and contracts between suppliers and buyers of technology will evolve to the above types of adjustment.

Finally, the market structure's representative explanatory variable, potential entry of new competitors, was significant for all adjustments options at the overall estimations. However, for textiles and clothing and footwear industries, cluster B, the explanatory variable was only significant in the case of the purchase of foreign technology and product licensing, indicating that in these industries this adjustment option must be the most frequent when the potential entry of new competitors is high. The same is valid for the food products industry, where it was also significant in the case of association with multinationals.

VI.6 - Summing Up

In this chapter, we analyzed the determinants of distinct adjustment options that could be undertaken by each firm/industry in reaction to Brazilian trade liberalization program that began in the early 1990s. These adjustments are not only an indicator of their main current deficiencies with the liberalization of the economy, but also gave a better idea of their future situation in terms of capital ownership, degree of vertical integration, diversification of production, and capital and human resources investments. By manipulating the main determinants of the adjustments decisions, among them property rights regime, science and technology policies, the velocity of trade liberalization and, in particular import restrictions on industry's modernization, one could affect the future profile of Brazilian industry and its insertion in the world economy.

From the thirteen adjustment options included in the survey, we selected four representatives for which the model was estimated. The first, was the perceived frequency of substitution of own production for imported products in the industry with the liberalization policy used as an indicator of the degree of substitutability of a firm's products as well as an indicator of the presence of market distortions among which is also included some unfinished or unsuccessful cases of "infant industry" protection. The second selected adjustment option was the perceived frequency of rationalization of production lines in the industry with the liberalization policy, an indicator of the gap in efficiency of production that was possible, given the past protectionist regime. The third adjustment analyzed here was the perceived increase in the frequency of purchase of technology abroad and/or licensing of products in the industry with the liberalization policy indicating which industries depend most on world markets of technology, an important issue when defining the country's property rights legislation. Finally, the last adjustment was the perceived potential association with multinational enterprises with the liberalization policy, an indicator of the future profile of the Brazilian industrial configuration and capital ownership.

The results of the estimated model also showed how combinations of particular shares of exports in a firm's total revenue, and differences on its main sources of technology, lead to specific adjustment options for each industry. Moreover, this chapter identified for which industries, firms that evaluated the ongoing trade liberalization to be too fast were the ones that needed for a greater amount of adjustments in order to cope with the new economic environment, such as the need to substitute its own production for imported products found in more than half of the industries surveyed. In some industries, firms that, even with the high levels of protection of the economy, were still exposed to foreign competition in the domestic markets declared that with trade liberalization, their adjustment options, i.e., their alternatives to face even greater competition, would also be to substitute their own production for imported goods. In these cases, as discussed in chapter I, the rationale of larger decreases of tariffs concentrated in intermediate and capital goods during the first two years, providing a temporary shield for the domestic consumer industry in order for its preparation for greater market competition, seemed to be appropriate. This rationale reduced the required "own production substitution" allowing for a smoother adjustment of these firms to face the foreign competition.

Finally, several other determinants were significant at the overall level such as: the greater the need for rationalization of production, the import restrictions on informatic goods, and the degree of competitiveness of the industrial market, the more frequent will tend to be all kinds of adjustment options. They had, however, distinct degrees of importance for each industry, a crucial factor to be taken into account when defining the country's economic policies and regulations.

In the next chapter we will examine the main determinants of a firm/industry technological strategy, another important aspect determining the degree of competitiveness of the Brazilian industry that we would like to have a better understanding.

VII - DETERMINANTS OF MAIN SOURCES OF TECHNOLOGY

This chapter attempts to contribute to a better understanding of the relationship between sources of technology and characteristics of Brazilian firms and industries, such as their market structure, degree of openness to foreign markets, location and previous exposure to foreign competition. Moreover, we shall look at the functioning of markets for technology, the recent evolution of the Brazilian science and technology program, and the relations among distinct sources of technology in the country. This could give guidelines on some relevant aspects to be considered when defining the appropriate science and technology policy and regulatory framework for the Brazilian current situation.

On the one hand, with the trade liberalization that began in the early 1990s, the reduction of import restrictions of equipments is allowing for a faster modernization of the domestic industry. On the other hand, part of the domestic machinery and equipment industry might not survive with foreign competition. Moreover, the new legislation on intellectual property rights that is currently under preparation could completely change incentives for innovation and the mechanisms of adoption of new technologies. The long run effect of those changes on the domestic technological capabilities and competitiveness is still not very clear.

In order to define a domestic technological strategy, it is important to have answers to questions such as: how does the process of flow of new technologies function, and whether or not and in which areas are domestic technological capabilities required in order to maintain a competitive domestic industry facing a greater opening of its markets.

As in the previous chapter, instead of having a single dependent variable, here there are five possible alternative sources of technology for which the model will be estimated:

- Firm's own technology development (44)
- Suppliers/buyers technology development (45)
- University/research institutes technology development (46)
- Engineering firms technology development (47)
- Foreign technology - technology developed abroad (48)

Each firm responded what was the degree of importance of each source in a scale from 1 to 6. These sources are not necessarily mutually exclusive. One could have, for example, a firm that depends on supplier's technology development which is made abroad.

Before we enter in the discussion of our initial hypothesis with respect to the relationship between these sources of technology and the explanatory variables, we shall have a brief discussion of specific aspects of technical change and diffusion and the Brazilian science and technology program.

VII.1 - Technical Change and Diffusion and The Brazilian Science and Technology Program

The basic question that we will try to answer in this section is what is the characteristics of the international technology market and how an industrializing country like Brazil, should define its science and technology strategy. We would like to have some possible answers to questions such as:

- How to make more compatible the domestic set of rules with the ongoing international technological and institutional changes; or
- What should be the appropriate roles of private and government sectors in the creation of technological capabilities in a country's specific historical and institutional setting.

In the subsequent sections, when looking at the survey responses, we will look at the specificities of each group of selected industries, enabling us to better understand what should be taken into account in defining an adequate science and technology strategy for each of them that would foster the economy's potential economic growth.

Following, we will start by looking into the specificities of markets for technology, in particular with respect to technical change and diffusion. Then we will present some stylized facts of the current international techno-economic context in which the Brazilian economy is inserted which includes an increasing global competition from industrialized and industrializing countries; greater domestic and international pressures for the opening of its domestic markets and enforcing domestic property rights; and a new technological paradigm. Finally we will give an overview of the

Brazilian science and technology program and the current propositions for a future strategy.

VII.1.1 - The Specificities of Markets for technology

Technology, here, is defined as a technique (a design) that is used to produce other products and services. This technology can be incorporated in machinery, equipments, special inputs, in a formula, in tacit know-how, etc. As the OECD (1989) report states,

> "... technology cannot be reduced to machines. It has to do with certain kinds of knowledge, which allow the adaptation of means to ends. Part of this knowledge is embodied in machines, but most of it is not. It is embodied elsewhere - in the brains of people, in organizational structures and in behavioral patterns, which in turn are conditioned by the strategies of different social factors and their patterns of conflict and co-operation." p.20

The above definition of technology leads us to the concept of technological paradigms, which define the "technological opportunities for further innovations and some basic procedures on how to exploit them".[1] Moreover, when defining a science and technology strategy we should not only understand the technological paradigm under which we are living, but the country's combination of technical and economic advantages, i.e., the entire cluster of interrelated technical, organizational and managerial innovations

[1] Dosi, 1988.

or, what is usually denominated by a techno-economic paradigm.[2] As Freeman (1988) states, in such paradigm "advantages are to be found not only in a new range of products and systems, but most of all in the dynamics of the relative cost structure of all possible inputs to production." (p.10) In this broad sense, as the OECD (1989) report states, technological change "cannot be separated from market structures, patterns of competition and social regulation, and from the quality of the educational system and of the labor force. It also does not occur in a vacuum. It is driven, to a very large degree, by the fundamental requirements of competition." (p.20)

When dealing with markets for technology we observe the presence of imperfect markets that give rise to externalities, and consequently, it would provide a case for market intervention to improve allocative efficiency, a policy strategy adopted by most industrialized countries and newly industrialized countries (NICs). The main features of technology markets imperfections are:

a) The existence of bounded rationality with asymmetric information among the agents involved in selling and buying technology;[3]

b) The existence of economies of scale and scope[4] in the process

[2] Freeman, 1988.

[3] Bounded rationality is a behavioral factor where people has limited information and limited ability to process it; implying incomplete information about market opportunities, limited ability to predict the future and consequently limited ability to pre-specify responses to future events. Moreover, asymmetric information means that people may know different things. (Alchian, 1988)

[4] Here, economies of scope are, for example, cost-saving externalities between several firms' product lines that would be benefiting from a common R&D center of basic research.

of technology innovation and level of adoption ("learning by using"[5]) which leads to problems of path-dependency and market power;

c) The international context of those transactions and the specificity of distinct countries' mobiles and non-mobiles endowments (human, capital, regulations, etc);

d) The existence of increasingly sunk costs both in the development and acquisition of new technologies.[6] For certain technologies, particularly the highly dynamic ones, that are mainly generated in the industrialized countries, we observe that over time the development of new technologies are facing increasingly high initial sunk costs and increasing returns in their process of development.[7] When this is combined with nearly zero marginal costs of replication by the developer of its new technology, if one is under an enforceable property rights regime and/or, if new technologies have an ever higher tacit content, the bargaining power between consumers and developers/suppliers firms would tend to shift in favor of the latter over time. Furthermore, once a consumer firm realized the necessary sunk costs in order to use a specific technology it might be very costly in a subsequent period to acquire a new technology, from an alternative supplier. In other words,

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[5] Rosenberg, 1982.

[6] Sunk costs, as used here, are costs, such as investments in plant, equipment, training, etc., which cannot be recovered when a firms stops a specific activity.

[7] Dosi *et al.*, 1990.

this firm could be "locked in" with its first supplier;[8] and

e) The existence of market failures due to the potential "volatility" of technology appropriability, i.e., property rights are not always well defined and enforceable. Technology is characterized by being a non-rival and partially excludable good. The degree of excludability varies from technology to technology. Those characteristics of technology raise serious problems for the developer's appropriability of the returns on his investments. It is discouraging for a developer to undertake R&D in "volatile" types of technologies[9]. In these cases, a possible alternative is the Government's undertaking of those developments by itself or giving incentives for it, such as sharing the private risks, or creating technological capabilities to replicate foreign innovations.

Due to the above characteristics of markets for technology, we observe the existence of a dichotomy between "static" or allocative efficiency (diffusion) and "dynamic" efficiency (innovation). This dichotomy between innovation and diffusion processes makes the definition of the most appropriate institutional environment more difficult. The set of rules that would give incentives for technical change is sometimes the opposite to the one that would stimulate diffusion. This dichotomy between technical change and diffusion is associated with the existence of appropriability

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[8] Arthur, 1989.

[9] Klevorick *et al*, 1987.

problems (market failures/externalities) in the markets of technology. Under the presence of market failures, together with the technology markets imperfections -such as increasing gains from scale in learning and R&D and imperfect information-, the set of rules that would maximize the wealth of a country in the short run is not necessarily the same one that would maximize its wealth in the long run. In other words, we could have the situation where a short run suboptimal institutional environment could be the optimal one in a long run perspective. Moreover, the best set of rules that would maximize economic growth not only changes over time but also can considerably differ from one country to another depending on their particular techno-economic characteristics.

Another important aspect that should be taken into account when defining a science and technology policy and its regulatory framework is with regard to the types of technology activities that occur in each level of aggregation. At the firm's level (intra- and inter-firms) is where the bulk of technology innovation and transfers generally takes place. This is where the distinct types of contractual arrangements and firms' technological strategies are defined. At the industry level, the characteristics of market structure plays an important role in determining how innovation and diffusion of technology occur. The greater the degree of domestic competition, the greater tends to be its international competitiveness. The degree of an industry's competitiveness will also affect the competitiveness of the entire set of interdependent industries -- an industrial complex. At the country level, technology transactions are directly influenced by the country's endowments, such as education, natural resources, infrastructure, regulation, etc.. Finally, there is a considerable proportion of technology transactions that takes place among agents from distinct countries with different endowments. Industrialized and industrializing countries' governments have played a fundamental role in shaping the international relations and their respective domestic successes and failures. Firms in industrializing countries are mainly characterized by being users of technology developed in industrialized countries. The form under which these technology transfers take place depends on the industrializing country's and firms' science and technology strategies in improving their domestic technological capabilities.

One of the main objectives of a science and technology strategy is the reduction of transaction costs in the markets for technology. The main aspects involved that should be looked upon in order to reduce the costs of transaction are behavioral factors, the institutional environment, the transaction's attributes, and the type of governance structure.

a) The main **behavioral factor** affecting the contractual arrangements for technology transactions is, as mentioned above, the existence of bounded rationality with asymmetric information among the agents involved in selling and buying technology, leading to opportunistic behavior.[10] Under bounded rationality, the agents not only don't know everything but, as in the case of transfer of

[10] Williamson, 1985.

technology, they may know different things. What each of the agents know is in part a function of the assets that each agent controls. Opportunistic behavior follows from bounded rationality plus self-interest. The two kinds of opportunism that we can observe are: a) when there exists asset specificity (such as sunk costs) it can lead to expropriation of quasi-rents; and b) moral hazard problems that can arise when one party relies on the behavior of another and information about that behavior is costly.[11]

b) The **institutional environment**, is related to the basic regulatory regime to be defined by a country such as property rights, levels of protectionism, foreign capital regulations, anti-trust laws, and the S&T system (government incentives, laboratories of basic science, university/firms relations, etc.).

c) **Transaction attributes** depend on the goods and services transacted. The main transaction attributes to be taken into account in the case of markets for technology are the following: appropriability, specificity of assets, frequency of transactions, level of uncertainty, asset indivisibility, how strategic the technology is for firm to remain competitive, and length of time of usefulness.

d) The good and services transacted, in turn, depend on the characteristic of the firms involved in the transaction, i.e., at what stage of the "technology development" is the transaction being

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[11] The developer of a technology (a process of production and/or a new material) detains an information advantage about its content and value. The consumer of technology, has information advantages about the market opportunities for the use of the technology.

undertaken. This is what will define the **governance structure** under which the transaction will take place. The degree of authority relation between the parties involved in a transaction can go from a total internalization as in foreign direct investment to arm's length types of transactions such as licensing contracts. Between these extremes we can find governance structures such as franchising, cross-licensing, joint ventures, sub-contracting original equipment manufacturer (OEM), long term contracts, turnkey contracts, etc..[12]

Given those behavioral factors and a given institutional environment, for each set of transaction's attributes a distinct type of governance structure will be the most appropriate to reduce the costs of transaction. In other words, the transaction's attributes associated with the characteristics of a specific technology - the specificity of assets required to execute the transaction, the frequency of the transactions, etc - and the institutional environment under which the transaction is undertaken - such as the country's property rights regime and its degree of enforcement - are fundamental factors for the determination of the efficient governance structure and its respective transaction costs.[13]

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[12] Original equipment manufacturer (OEM) is a specific form of sub-contracting, that like a joint venture it requires close connection with the foreign partner. Under OEM deals, the local firm produces a good to the exact specification of the foreign company that markets the product through its own distribution channels, under its own brand name. (Gibbons, 1995)

[13] Governance Structures are endogenous to the transactions attributes, the institutional environment, and the equilibrium expectations of the parties involved given their bounded rationality and the fact that they learn from the past.

In the Brazilian case, for example, Braga and Willmore (1988), based on a 1980 survey of Brazilian firms, found that imports of product designs would occur with a high probability in the chemicals and clothing industries, and with low probability in the paper and perfume industries; imports of instrument designs would occur with a high probability in the beverages and chemicals industries, and with low probability in the plastics and leather products industries; imports of processes of production would occur with a high probability in the nonmetallic mineral products and chemicals, and with low probability in the clothing and leather products industries; imports of industrial installation projects would occur with a high probability in the chemistry and nonmetallic mineral products industries and with low probability in the clothing and leather products industries; and, finally, imports of lay-out plant projects would occur with a high probability in the chemistry and nonmetallic mineral products industries and with low probability in the clothing and plastic products industries.

The dynamics of the process defining governance structures function as follows: over time, the parties involved in a transaction will tend to engage themselves in improving their bargaining power by influencing changes in transaction attributes and in the institutional environment such that their net benefits in future governance structures would increase. For example: Holding fixed the institutional environment, we can observe that a developer's degree of appropriability can increase over time if he produces new technologies that will increase his relative technology informational advantage (e.j. develop new technologies with a high tacit content). By following this strategy he would be changing the initial transaction's attributes and consequently the governance structure that would be considered the most efficient by the parties involved. Similarly, the individual firms that are searching for new technologies will tend to formulate strategies - such as increasing its own technological capabilities - leading towards the opposite direction.

This dynamic process is what Dosi *et al* (1990) calls technological trajectories within technological paradigms. A technological trajectory is defined as technological progress along the economic and technological trade-offs defined by a paradigm. The nature of the technological trajectories allows us to distinguish two broad groups of firms/industries: developers and consumers of technology.

a) There exists basically two types of **developer firms/industries**. First, the 'specialized suppliers' (suppliers of equipment and instruments) to whom the appropriability of its technological advances depends "to a considerable degree on firm-specific skills reflected in continuous improvements in product design and product reliability, and in the ability to respond sensitively and quickly to user's requirements".[14] Second, the 'science-based' (electronics/electrical and chemicals) that "appropriate their innovative leads through a mix of methods (e.g., patents, secrecy, natural technical lags, and

[14] Dosi *et al*, p.96-97.

firm-specific skills)".[15]

b) The **consumer firms/industries**, on the other hand, can also be classified into two groups. First, the 'supplier-dominated' (textiles, printing and publishing, agriculture and construction) that "appropriate less on the basis of a technological advantage than on the basis of professional skills, aesthetic design, privileged access to a resource (such as fertile land), trademarks and advertising".[16] Second, the 'scale-intensive' (steel, glass, consumer durables, autos) whose appropriation is based on process secrecy and know-how, technical lags, patents, and economies of dynamic learning.

Each new technological paradigm, allows for distinct possibilities of technological trajectories. We could look, for example, to technological trajectories that emerge over time from the transactions of equipments between the 'specialized suppliers' industries and the 'supplier-dominated' industries. In general, the tendency of those technological trajectories has been towards the increasing mechanization/automation of the equipment supplied. Among the reasons to these technological trajectories, we could mention the following:

a) The long-term trends in the relative price of machines to

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[15] *Ibid.*, p.98.

[16] *Ibid.*, p.92.

labor.[17]

b) From the demand side, i.e., 'supplier-dominated' industries, the reasons could be because 'machines do not strike'[18], and also because they make less 'errors', i.e., better quality of final products.

c) From the supply side, the technological trajectory is also affected by the 'specialized-suppliers' industries' strategy of improving their possibilities of extracting greater monopoly rents from the 'supplier-dominated' industries. Over time, the latter could face themselves in a lock-in technological trajectory, that would be too expensive to switch.[19]

d) Moreover, from the 'specialized suppliers' industries' point of view, this higher capital to labor ratio is also expected in order to increase their share of the total value of the investments undertaken by the 'supplier-dominated' industries. Furthermore, the better equipments are, in general, simultaneously inputs- and labor-saving, i.e. changes in relative prices will never make the previous technique superior to the new one.

If we simply look to the efficiency of a governance structure from the perspective of the private agents directly involved with

[17] *Ibid.*, p.104.

[18] Rosenberg, 1986.

[19] Arthur, 1988.

it, we would be neglecting a more complete picture of the economic problem existent in the transactions of technology. Private agents, while making their decisions on how to improve their bargaining power, take into account only their own private interests. Under those circumstances we can show that, due to the presence of market failures in the markets of technology, the governance structures observed in those markets will not necessarily be the most efficient ones from the society's perspective. In other words, the private efforts made by a developer of technology towards an improvement of his bargaining power through more tacit technology, or a costly replication of the technology capabilities already available made by consumers of technology, are not necessarily increasing the efficiency of the economy as a whole. When those features are observed, there is room for a better institutional environment that could be set in order to reduce those market imperfections, and the society's transactions costs.

If for certain private agents, market intervention might be constraining their alternatives, resulting in a less profitable outcome from their individual perspective, in a global perspective, when externalities are taken into account, the net results could have a different sign. Whether it will be welfare improving or not will depend on the adequacy and effectiveness of the interference, since both alternatives, at least in the short run, are still second best[20].

[20] Patents, for example, are a type of market intervention that guarantees a monopoly of the invention for its creator for a given period of time. Had it not existed, many types of innovations might not have occurred. But what is the

Several regulating institutions are concerned with the impacts of those externalities that are directly or indirectly interfering with the private agents' decisions. Among those institutions the most important are governments and their respective agencies, at the national level, and multilateral organizations such as the World Trade Organization, the United Nations and the European Union at the international level.

Based on this framework of analysis of markets for technology we could summarize some interesting results that should be taken into account when defining a country's S&T strategy, as follows:

a) The domestic and international institutional environment -the set of rules of the game- is a fundamental factor in determining the pace and direction of technical change.

b) This set of rules, such as the property rights regime and its enforcement, also plays a crucial role in directing the process of technology diffusion, another significant determinant of economic growth. Diffusion becomes even more relevant when we assess the insertion in the world economy of an industrializing country like Brazil where most of the innovations that are incorporated in the economy have occurred abroad.

c) The institutional environment itself changes over time in response to technical changes and diffusion.

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socially optimum length of a patent is still a polemic question. Another example, is the restriction on foreign direct investments in order to protect the domestic industry, which in turn might have reduced the transfer of more volatile technology that can not be available other than through internalization.

d) There exists a dichotomy between innovation and diffusion processes and the definition of the most appropriate institutional environment. The set of rules that would give incentives for technical change is sometimes the opposite to the one that would stimulate diffusion.

e) The externalities generated by market failures together with the presence of transactions costs provides a case for market intervention to improve the allocative efficiency: a second best alternative. Another motive supporting market intervention is the uneven distribution of developers and consumers of technology among countries leading to "virtuous" and "vicious" circles of technology advance, respectively, given their distinct dynamic potential in terms of economies of scale, technical progress, learning by doing, etc.. [21]

The Government's main objective should be to maximize the country's expected long run economic growth, i.e., to maximize the country's expected returns on the process of generation, exchange and use of technologies. At the domestic level, it should provide incentives to accelerate the process of technological innovation and diffusion within the economy. At the international level, the main objective should be to minimize the costs and accelerate the

[21] In the dynamic bargain process between developers and consumers of technology, the former tend to, over time, increase their rents in the international context and, since not all factors are mobile internationally, those "consumer countries" would face a relative decline in their economic situation when compared to "developer countries". In the past years, we observed an increasing share of high technology products in international trade which could lead to a deterioration of "consumer countries" terms of trade.

process of absorption of imported technology and to maximize the returns of the imported or domestically developed technology, through international transactions of technology and/or of their products.

Government policies will affect the governance structures and the pace under which technology will be generated and diffused. The government can influence the costs of domestic firms in absorbing foreign technology. Moreover, the lower the potential costs for domestic firms to develop new competitive technologies, the smaller are the rents that foreign developers can extract from market sales or from the direct use of their technologies. Finally, there is no reason to believe that the lines between what society wants to leave private and what society wants to make public will remain constant over time. A central part of society's economic problem, then, is the need to continuously draw and redraw these boundary lines.

VII.1.2 - Some Stylized Facts of the Current International Techno-Economic Context

Among the main striking international trends that one should take into account in order to better understand the current functioning of world markets for technology and the current technological paradigm, are the following:

a) Increasing global competition from industrialized and industrializing countries.

b) Rising shares of international trade in world output, with increasing shares of high-tech products in international trade.

c) The electronic complex became the dynamic sector of industrial growth, a role played by the metal/machinery industries in the 1970s. Microelectronics, in particular, became the main inducer of technical progress.[22] The electronic complex share of world industrial aggregate value increased from 3.5 percent in 1980 to 12 to 14% today, and this complex is becoming more and more important in the production of capital goods, increasing the importance of integration between the producers and users of new technology.

d) Mass production in giving way to more flexible and customized production and shorter product life cycles.

e) Increasing costs of research and development (R&D) in high-tech sectors leading to technological alliances, with firms competing in the sales of their products.

f) With the acceleration of the pace of technical innovation and competition in industry, industries are required to permanently change their organization, absorb new technologies and processes and generate new products, leading to an industrial labor force characterized by highly skilled and motivated workers, and reductions in administrative personnel and non-qualified workers.[23]

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[22] Coutinho, 1994.

[23] Schwartzman, 1995.

g) A growing importance of the tacit know how. Most of the time high technologies do not allow any type of commercialization other than the direct use by the owner, given the risks of losing the exclusivity of its knowledge. In other words, these are core technologies that could not be marketed under the form of royalties or licensing, but that can only be kept exclusively through direct control. In those cases where technological secrecy is fundamental in order to detain the diffusion of the enterprise's core knowledge, control is mainly motivated by the strategic problem of appropriating rents from technology, and access to capital can be a secondary priority.[24] As an example, we can mention the increasing formation of joint ventures where the parent company detains the control of technology independently of its equity participation.[25]

h) Greater pressures for the opening of domestic markets and enforcement of property rights.

i) Increasing difficulties by industrializing countries in acquiring and introducing innovations generated by the more

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[24] As Krugman (1990) states, "Probably the main contribution of the new literature on multinational enterprise has been to clear away some confusions about what multinationals do. What the new models make clear, above all, is that multinational enterprise is not a type of factor mobility. It represents an extension of control, not necessarily a movement of capital. The key lesson is that direct foreign investment is not investment." (p. 82-83)

[25] "Control, therefore, is motivated first and foremost by the strategic problems of appropriating rents from technology, and only secondarily by access to capital. When capital transfers are involved, it is often because the reputation of the firm that owns that technology is stronger in its home country than it is abroad or that capital is cheaper there, so that technology and capital are transferred as a bundle to the LDC." (Mark Casson and Robert D. Pearce, in Gemmeill, Norman 1987, pp.91).

advanced economies. Among new strategies, followed by South Korea, Taiwan and also by Japan in order to have access to new technologies is the installation of R&D centers in the USA and Europe, the purchase of small American firms, and the creation of an industrial structure with a level of competition that allows it to obtain frontier technology.

j) The existence of dynamic economies of learning and R&D, combined with increasing returns in technological development by imperfectly competitive industries helps to explain the tendency to international specialization.[26]

k) Industrialized countries have been rethinking their R&D systems, by eliminating certain antitrust laws, allowing for cooperation (e.g., the Sematech experience in the United States and the Eureka projects in Europe[27]), Government sharing risks, better integration of universities and private sector, bilateral trade negotiations, and concentration of efforts in the development of generic technologies (information, communications, biotechnology and advanced

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[26] "There is a natural alliance between the new trade theory, with emphasis on increasing returns and imperfect competition, and the view that technological change is a key factor driving international specialization. The two views are not necessarily linked: conventional trade theory can say many useful things about the effects of technological change (though little about its causes), and many of the new models focus on garden-variety static scale economies. Nonetheless, technological development is normally an increasing returns process carried out in imperfectly competitive industries, and the most important sources of increasing returns in practice probably lie in dynamic economies of learning and R&D." (Krugman, Paul, 1990, p.7).

[27] The Eureka projects involve projects in the following areas: medical and biotechnology, communications, environment, information technology, lasers, materials, robotics and production automation, transport.

materials).[28] Direct and indirect fiscal/financial support to the industry constitutes one of the most important policy instruments of OECD countries, with a net cost for their Governments of more than US$260 billion, or 2-3 percent of the manufacturing value added of these countries, during the period 1986-89.[29]

l) The increasing returns on learning and R&D, combined with an increasingly integrated world economy, are among the main reasons for the industrialized countries' observed trend of specialization in a reduced number of high-technology industries. This allows these countries to reduce competition and maintain a relative market power in specific products that they trade internationally.

m) Government support became more focused in three major areas: strengthening foreign competition, support for R&D and technological diffusion, and regional support for industrial reconversion and self-sustainable development.[30]

Some specific problems of technological learning and accumulation faced by countries that are not in the technological frontier are:

a) Due to their lag in the international technological frontier, their products tend to face more competitive markets;

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[28] Mowery (1989), Coutinho (1994), and Schwartzman (1995).

[29] Coutinho, 1994.

[30] Coutinho, 1994.

b) Incomplete specification of the imported technological package generates problems of adaptation and inefficiencies;

c) They are geographically more distant from the equipment producers, having a smaller influence in incorporating their specific needs in the equipments acquired;

d) Problems of imperfect information, absence of markets, and institutional fragmentation and fragility are deeper than in developed countries; and

e) They face static and dynamic diseconomies of specialization and learning due to, reduced size of domestic markets, greater vertical integration, and greater "mix" of products.

Higher and sustainable economic growth is associated with the implementation of a competitive industrial strategy, where the increase of the Brazilian insertion in the world economy plays a fundamental role. Historically, economic catching-up effort comes with technological catching-up in the new and most dynamic technologies, irrespective of the initial patterns of comparative advantages, specialization and market-generated signals.[31] In order for an industrializing country to not permanently face the distress of excess supplies of primary and low-technology products, a possible alternative would be to promote specific high-technology sectors[32]. This strategy will take different forms for each country

[31] Dosi *et al*, 1990.

[32] Lafay (1990) states that "... nations which create or attract the most performant enterprises can question all the advantages which were acquired in the past by the old industrialized countries".

depending on its specific characteristics and stage of development[33], as well as on the specific markets' characteristics.

VII.1.3 - The Brazilian Science and Technology Program

After the 1970s' rapid expansion of the Brazilian science and technology program, it entered in a period of instability and uncertainties, marked by reduced and uncertain resources, successive institutional reorganizations, and lack of clear direction. Between 1981 and 1990, Brazil spent between US$2-3 billion a year, 0.6 to 0.8 percent of GDP, in science and technology activities.[34] Of these expenditures, only about 6 percent came from the private sector, from firms such as Aracruz Celulose (paper), Itautec (computers), Aço Villares, Metal Leve (mechanical components), and Elebra (computers). Another 10 percent of these science and technology expenditures came from state-owned enterprises, such as Petrobrás (oil), Telebrás (telecommunications), Eletrobrás (electricity) and Embraer

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[33] As an example, we could mention the strategy that is being implemented in Taiwan though the creation of Government's science parks, that have as their main objective, the development of high-technology niches. For Taiwan and other Asian Newly Industrializing Countries, labor costs have been rising as their economy matures. Their traditional markets are being occupied by other countries with cheaper labor like China. And the only alternative to keep an international competitive edge is investing in higher technology products.

[34] In 1988, OECD countries spent about 2.5 percent of their GDP in research and development, of which between 40 to 50 percent was made by the private sector. In South Korea, where R&D expenditures represent about 2 percent of GDP, the private sector increased its participation from 36 percent in 1976 to 81 percent in 1988. (Branscomb, 1995, and Coutinho, 1994)

(airplane construction) which was recently privatized.[35]

The Brazilian scientific activity is relatively small, less than 1 percent of the scientific research in the world, and its performance is not proportional to its Gross National Product and population. The table below shows various regions performance measured by its scientists' share of scientific articles, the extent to which their articles are cited in other articles, other researchers' mentions of them as principal contributors, and mentions of them as influences upon research elsewhere in the world. As Schott (1995) states, "scientific performance in a country is not a reflection of the size of the country in terms of population or economy. These differences in scientific performance seem shaped by differences in institutionalization of science". (p.241)

Table VII.1

Scientific Performance, Juxtaposed to Economy and Population [a/]

	Performance in Scientific Research				Gross National Product	Population
	Articles	Cites	Contributions	Influencers		
Brazil	0.3	0.2	0	0	1.7	2.8
Other LA	0.8	0.4	0.1	0.3	3.0	5.3
Israel	1.0	0.9	2.0	0.6	0.2	0.1
North America	40.9	54.8	49.0	45.9	31.3	5.4
Western Europe	30.8	30.8	35.2	33.9	22.7	7.2
Rest of the World	26.1	13.0	13.7	19.3	41.2	79.2

a/ Percentage distribution of articles, 1986; citations, 1980-85; contributors named in a survey; influences named in a survey, Gross National Product, 1986; and population, 1986.
Note: The percentages in each column sum up to 100 percent except for rounding.
Source: Schott, 1995.

An extensive policy study on science and technology in Brazil, coordinated by Simon Schwartzman (1995), points out that during the

[35] Schwartzman, 1995.

1980s, "the links between science and technology and the productive sector remained weak, lacking demands for advanced technology, in an economic environment characterized by protectionism and reliance on cheap labor and natural resources."(p.13)

While in other countries industrialization was accompanied by a significant R&D effort by local firms and by the constitution of an articulated infrastructure of technological services, the Brazil's industrialization did not exert a direct pressure over the domestic supply of technology. Moreover, domestic firms tend to be relatively small when compared to international sizes in terms of sales and assets, and are mainly concentrated in the more conventional productive activities, lacking their presence in industries that are the engine of technological innovation. We observe, however, some punctual success stories among state enterprises in areas such as aerospace, petroleum, electrical power and smelting; and also in the private sector in areas such as special metal materials and banking automation.[36]

During the 1980s, Brazil had a smaller volume of imports of technology when measured by the number of contracts, a greater restriction in the transfers of sensitive technologies, the country's S&T policies were less specialized and with less exchange of technology (at a smaller scale than in South East Asia countries), weak industry-government-universities links, together with, as discussed in chapter I, increased macroeconomic instability due to external and domestic factors.

[36] Coutinho, 1994.

In the early 1990s, one starts to see a trend towards a more integrated process between science and technology and industrial competitiveness. Some features of this new trend was the gradual extinction of market protection of computers, telecommunications, microelectronics and supplying industries;[37] the transformation of the Financing Agency for Studies and Projects (Finep) into an agency mainly directed to the financing of industrial technology; the increasing support for the creation of "technological parks" near main universities; the freezing, or reduction of large governmental R&D projects, such as the nuclear and the military aircraft programs; and the establishment of a few governmental programs to stimulate quality and competitiveness in industry. With the trade liberalization that began in the early 1990s, there also was a tendency for a reduction in domestic R&D expenditures at firms' level, which was considered a more pragmatic strategy, but with risks of loosing technological capability in the longer term.

The main conclusions of Schwartzman's study point to the new strategic role that science and technology should play, given, among other things, the need to improve productivity in the economy, and to participate more fully in an integrated world economy and society. It proposes that the basic assumptions of Brazil's science and technology of the 1970s, of concentration of efforts and resources in a few large strategic projects, "to free

[37] A survey made by the Brazilian Association of Machinery Producers - ABIMAQ in 1989, showed that the firms with the greater technological lag were the ones that depend on the electronic sector: mechanics, transport equipment, and textiles.

the country from the *technological encirclement* of foreign governments and multinational firms, and to generate poles from which scientific and technological competence could *trickle down* to the economy and society as a whole", should be substituted for an understanding that "although proprietary knowledge is in the rise worldwide, and controls of the transfer of military sensitive technologies persist, the key element allowing access to the benefits of scientific and technological developments is in the general competence of the population and of the economic system as a whole."

The basic policy propositions of Schwartzman's study, which are consistent with our previous analysis of the current functioning of the markets for technology, are the following: a) full participation in international scientific networks; b) creation of small and highly qualified research establishments; c) widespread diffusion of basic technological competence and professional education; d) light, rapid and efficient science and technology decision mechanisms, with strong emphasis on decentralization and local autonomy; e) greater association with private sector; and f) careful evaluation of the costs, benefits and alternative use of resources, specially regarding large scale projects. The study also argues that "the country should not renounce its instruments of technological and industrial policy, including tax incentives, tariff protection, patent legislation, government procurement and long-term investments in technological projects, in association with the private sector." (p.5)

In the study, coordinated by Coutinho and Ferraz (1994), they make some propositions for the institutional strengthening and reorganization of Brazilian S&T main agencies, which includes among others the Ministry of Science and Technology, Finep, the National Council for Research (CNPq), Capes, state institutes and research centers, Banco do Brasil, and BNDES. Their main propositions of institutional restructuring for the improvement of planning, coordination and support of scientific and technological development are the flexibilization of their operational and financial capabilities, and the strengthening of their ability to operate and make more dynamic new forms of support seeking the enhancement of diffusion of knowledge and new technologies, and of connections between researchers, suppliers, producers and users.

With the above analysis of the functioning of markets for technology and a short review of the past Brazilian S&T experience, following the methodology adopted in previous chapters, we now turn to a discussion of our initial hypothesis with respect to the relationship between the sources of technology and the explanatory variables.

VII.2 - Initial Hypothesis

- *Explanatory Variable 1 - Firm's location.* (5,55) (Classified in ascending order of States/regions' Gross Industrial Product)

In the richer states/regions, we would expect that all sources of technology could have a significant degree of importance.

However, in these regions, it would be easier to have a qualified staff "in house" that could develop its own technology or apply sophisticated foreign technology than in the poorer states/regions, where one has less availability of qualified human capital, and firms' technological needs will generally be obtained from their main suppliers and buyers or by contracting the services of engineering firms, universities and research institutes. Given that, we would expect a negative sign with respect to the above mentioned sources of technology and a positive coefficient with respect to firms' own technology and foreign technology sources. A science and technology policy should take into account the distinct needs faced by each regions and type of industry.

Two types of location classification will be tested separately. The first classification (variable 5) grouped the states into six groups based on the size of their economy measured by their share in total GDP. The second classification (variable 55), did the same with the five geographic regions (see ANNEX 1).

- *Explanatory Variable 2 - Share of exports in firm's total revenues.* (12) (see scale in ANNEX 1)

In order to compete in the international markets, industrial firms have to be as close as possible to the technological frontier used in their respective industries. For that reason, we would expect a positive correlation between share of exports in total revenues and the importance of all five sources of technology. In the final estimations, it will be interesting to see the distinct degree of importance of each source of technology for each specific cluster of industries.

- *Explanatory Variable 3 - Perceived exposure to foreign competition*. (10) (1-very low, 6-very high)

As in the previous chapter, if certain firms, even with high levels of protection, are still facing foreign competition in the domestic markets, this is probably an indicator that these firms have a considerable technological gap in their production lines. Since, as shown in chapters I and IV, the Brazilian protection levels were high at the time of this survey, we would expect a negative coefficient on this explanatory variable. Here again, the estimation of the expected marginal effects for each specific cluster of industries could give an indicator of the magnitude of this technological gap in each of them.

- *Explanatory Variable 4 - Perceived market structure.* (49-54) (1-very low, 6-very high)

As mentioned in chapter IV, there were six competitive forces included in the survey. The first five forces correspond to Michael E. Porters' scheme of industry structural analysis.[38] The last variable, potential entry of imported goods, was introduced to highlight firms' perceptions of the potential effects of the trade liberalization program.

The table below shows the expected coefficient signs for each

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[38] Porter, 1985.

indicator of market structure contained in the survey with respect to the five sources of technology. We placed a question mark in the cases where we had no specific expectations on the signs of the coefficients. The main reasons behind these expected signs are the following.

We would expect that the more competitive is an industrial market, when measured by variables 51 to 54, the more important the specific capabilities intrinsic to each firm would be, such as the firm's own technology development. We would also expect the same with respect to the importance of its exclusive access to external technologies through suppliers and buyers, university and research institutes, engineering firms and foreign technology.

We do not expect that the coefficient signs of suppliers' and buyers' market power will be the same for all sources of technology. These signs will certainly be positive for suppliers/buyers own technology development. For foreign technology development, we also expect a positive sign since in many cases the foreign firm is also the main supplier and/or buyer of the Brazilian firm. On the other hand, we expect a negative coefficient sign for University/research institute technology development since when these sources are used, they are in general not directly related to the firm. Instead, they tend to be directly related to the firm's suppliers and buyers of intermediate and final products. The greater the market power of the suppliers and buyers, the stronger is their influence in defining the technology to be adopted by the firm, reducing the importance of firm's direct contact with University/research institute sources of technology. Finally, with respect to firms' own technology development and engineering firms, we do not have any particular expectation on the coefficient signs or even whether they ought to be significant.

Table VII.2

Expected Coefficients Signs on Market Structure Regressors

Explanatory Variable	Expected Coefficient Sign Per Source of Technology				
	Firms' Own Tech	Sup./Buyers	Univ./Res. Inst	Engineering Firm	Foreign Tech
Suppliers' market power (49)	?	+	-	?	+
Buyers' market power (50)	?	+	-	?	+
Rivalry among producers (51)	+	+	+	+	+
Veloc. of introd. of new prod.(52)	+	+	+	+	+
Potential new competitors (53)	+	+	+	+	+
Pot. entry of imported goods (54)	+	+	+	+	+

Let us now turn to correlations and principal components analysis in order to select the explanatory variables to be kept in the estimations of the probit and logit models.

VII.3 - Correlations and Principal Components Analysis

Before the analysis of each explanatory variable, we will examine the relations among the sources of technology and their importance in the Brazilian industry. This will allow a better understanding of their pattern of behavior with respect to the explanatory variables.

VII.3.1 - Relation Among Distinct Sources of Technology and Their Importance in the Brazilian Industry

As can be observed in the table below, all five sources are significantly positively correlated among each other --in particular among universities, research institutes, engineering firms, suppliers and buyers-- meaning that the sources of technology are not mutually exclusive. On the contrary, their complementarity is an important factor that should be considered when defining science and technology policies and property rights legislation. The same result was obtained by Braga and Willmore (1988), when looking at the results of a 1980 survey of Brazilian firms when looking at the complementarities between imports of technology and own R&D activities.

Table VII.3

Sample Correlations[a]

	Firms' Own Tech.	Suppliers/Buyers	Univ./Res. Inst.	Engineering Firm	Foreign Tech.
Firms' Own Tech.	1.0000 (664) .0000	.1961 (652) .0000	.1916 (655) .0000	.0832 (649) .0342	.0831 (655) .0336
Suppliers/Buyers	.1961 (652) .0000	1.0000 (654) .0000	.3302 (651) .0000	.2936 (644) .0000	.1479 (648) .0002
Univ./Res. Inst.	.1916 (655) .0000	.3302 (651) .0000	1.0000 (658) .0000	.6141 (648) .0000	.0676 (651) .0848
Engineering Firm	.0832 (649) .0342	.2936 (644) .0000	.6141 (648) .0000	1.0000 (650) .0000	.1192 (649) .0023
Foreign Tech.	.0831 (655) .0336	.1479 (648) .0002	.0676 (651) .0848	.1192 (649) .0023	1.0000 (659) .0000

a/ Coefficient (sample size) significance level.
Source: Author's own calculations.

The table below shows summary statistics on the firms' responses on the importance of the sources of technology. The first column reports the mean response for all firms to each question, as well as the standard error of each estimated mean. In order to have an idea of the distribution of industry means responses, the second column gives a summary of the distribution to each question.[39] Each pair of numbers represents the range of industry means from the upper bound of the lowest quintile to the lower bound of the highest quintile of industries: 20% of the surveyed industries had mean responses at or below the bottom of the range indicated for each question, and 20% had mean responses at or above the top of

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[39] This methodology of analysis was also employed by Klevorick, et al (1987) when analyzing a similar type of survey on forms of appropriating the returns from industrial research and development.

the range. Mean responses for the remaining 60% fell within the reported range.

Table VII.4

Importance of Sources of Technology [a]

Sources of Technology	Overall Sample Means	Distribution of Industry Means [b]	# Obs.
Own Firm	4.57 (1.19)	4.10 - 5.00	664
Supplier/ Buyer	4.03 (1.28)	3.67 - 4.42	654
University/ Research Inst.	3.43 (1.47)	3.04 - 3.96	658
Engineering Firm	3.17 (1.40)	2.86 - 3.58	650
Foreign Tech.	4.54 (1.36)	4.25 - 5.00	659

a/ Range: 1 = little importance; 6 = very important. Standard errors in parenthesis.
b/ From the upper bound of the lowest quintile of industries to the lower bound of the highest quintile.
Source: Author's calculations from C.N.I. survey.

One observes that the two most important sources are "own firm" and "foreign technology": only 20% of the industries surveyed rated these sources at or below 4.1 and 4.25 in its degree of importance, respectively. For the "own firm" source, these industries were wood products, plastic products, tobacco, and printing and publishing. For the "foreign technology" source, these industries were clothing and footwear, food, beverages, and also tobacco products. On the top 20% in its degree of importance,i.e., industries with means above 5, one finds mining, transportation equipment, rubber, and leather products, in the "own firm" source, while for the "foreign technology" source, they were mining, machinery, leather, and pharmaceutical and veterinary products.[40] The two least important sources of technology were "university and research institutes" and "engineering firms", while "supplier and buyer" was closer to the two main important sources. Among the reasons for the smaller importance of these sources is the lack of better channels of communication between these institutions and the industrial sector, as well as a weak legislation on property rights that inhibits the markets for licensing of products and processes of production. In our interviews in Brazil, many firms stated that universities and research institutes were not able to develop the entire production process but only pieces of it, making easier for them to buy the entire "package" from abroad.

The table below gives a summary of the distribution of the importance of each source of technology within each industry. Fifty percent of the firms' responses for each industry fell within the reported range. This table shows that the dispersion of the importance of each source of technology varies considerably among industries, a feature that could not be noticed by simply looking at the previous table. For example, although the perfumes, soaps and candles industry was not included among top quintile of industries with means above 5 for "foreign technology" as source of technology, 25% of its firms declared that such source was at least

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[40] Mining and leather products industries were at the top 20% of both sources.

rated 5.5. We also would like to highlight the fact that, for all industries, at least 25% of their firms gave an importance of 4 or more for all types of sources of technology, reinforcing the idea that all sources should be looked at thoughtfully by government agencies responsible for the country's science and technology policy decisions.

With the Brazilian trade liberalization, a particular concern of ours is that the country could end up losing a good part of its domestic technological capabilities, since in many cases import of foreign technologies would be, at least in the first moment, a cheaper way to obtain it. The consequences in the longer term are that the country would become more and more dependent on foreign sources of technology that sometimes have a very discretionary accessibility determined either by the suppliers' own strategic decisions, or by security reasons of the developed countries' governments.[41] In other words, although one observes a globalization of production, the diffusion of technology becomes more and more one of the main strategic sources of competitive advantage.

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[41] A recent example of the latter is the 1992 negotiations with the United States government to allow the shipment of a super computer bought by the Brazilian government from IBM.

Table VII.5

Importance of Sources of Technology per Industry [a]

#	Industry	Sources of Technology				
		Own	S/B	U/RI	Eng.F.	Foreign
1	Mining					
	1st.Qrtl	4.5000	3.7500	2.2500	2.2500	4.5000
	3rd.Qrtl	5.5000	5.2500	4.7500	4.7500	5.5000
2	Non Metallic Mineral Products					
	1st.Qrtl	3.0000	2.2500	2.2500	2.0000	2.2500
	3rd.Qrtl	5.0000	4.7500	4.7500	4.0000	4.7500
3	Metal Products					
	1st.Qrtl	2.2500	2.2500	2.2500	2.2500	2.2500
	3rd.Qrtl	4.7500	4.7500	4.7500	4.7500	4.7500
4	Machinery					
	1st.Qrtl	2.2500	2.2500	2.2500	2.0000	2.2500
	3rd.Qrtl	4.7500	4.7500	4.7500	4.0000	4.7500
5	Electrical and Communic. Equip.					
	1st.Qrtl	2.2500	2.2500	2.2500	2.2500	3.0000
	3rd.Qrtl	4.7500	4.7500	4.7500	4.7500	5.0000
6	Transportation Equipment					
	1st.Qrtl	3.0000	3.0000	2.2500	2.0000	2.2500
	3rd.Qrtl	5.0000	5.0000	4.7500	4.0000	4.7500
7	Wood Products					
	1st.Qrtl	2.7500	3.0000	3.0000	2.0000	2.7500
	3rd.Qrtl	4.2500	5.0000	5.0000	4.0000	4.2500
8	Paper Products					
	1st.Qrtl	3.0000	3.0000	2.2500	2.2500	3.0000
	3rd.Qrtl	5.0000	5.0000	4.7500	4.7500	5.0000
9	Rubber Products					
	1st.Qrtl	3.0000	3.0000	2.2500	2.2500	3.7500
	3rd.Qrtl	5.0000	5.0000	4.7500	4.7500	5.2500
10	Leather Products					
	1st.Qrtl	3.7500	3.0000	3.5000	2.0000	3.7500
	3rd.Qrtl	5.2500	5.0000	4.5000	4.0000	5.2500

Table VII.6

Importance of Sources of Technology per Industry (cont.)

#	Industry	Sources of Technology				
		Own	S/B	U/RI	Eng.F.	Foreign
11	Chemicals					
	1st.Qrtl	3.0000	2.2500	2.2500	2.2500	2.2500
	3rd.Qrtl	5.0000	4.7500	4.7500	4.7500	4.7500
12	Pharmaceutical Products					
	1st.Qrtl	2.2500	2.2500	2.2500	2.0000	3.0000
	3rd.Qrtl	4.7500	4.7500	4.7500	4.0000	5.0000
13	Perfumes, Soaps and Candles					
	1st.Qrtl	3.7500	2.0000	2.2500	2.2500	4.5000
	3rd.Qrtl	5.2500	4.0000	4.7500	4.7500	5.5000
14	Plastic Products					
	1st.Qrtl	2.2500	3.0000	2.0000	2.0000	2.2500
	3rd.Qrtl	4.7500	5.0000	4.0000	4.0000	4.7500
15	Textiles					
	1st.Qrtl	2.2500	3.0000	2.2500	2.2500	2.2500
	3rd.Qrtl	4.7500	5.0000	4.7500	4.7500	4.7500
16	Clothing and Footwear					
	1st.Qrtl	2.2500	2.2500	2.2500	2.2500	2.2500
	3rd.Qrtl	4.7500	4.7500	4.7500	4.7500	4.7500
17	Food Products					
	1st.Qrtl	2.2500	2.2500	2.2500	2.2500	2.2500
	3rd.Qrtl	4.7500	4.7500	4.7500	4.7500	4.7500
18	Beverages					
	1st.Qrtl	3.5000	4.2500	3.5000	3.5000	3.5000
	3rd.Qrtl	4.5000	4.7500	4.5000	4.5000	4.5000
20	Printing and Publishing					
	1st.Qrtl	2.2500	3.7500	2.2500	2.2500	3.0000
	3rd.Qrtl	4.7500	5.2500	4.7500	4.7500	5.0000

a/ Range: 1 = little importance; 6 = very important. Standard errors in parenthesis.
Source: Author's calculations from C.N.I. survey.

We shall now turn to the analysis of correlation and principal components of each explanatory variable.

VII.3.2 - *The Explanatory Variables*

- *Explanatory Variable 1 - Firm's location.* (5,55)

The sample correlations between location variables and sources of technology had the expected coefficient signs in all significant results, confirming the initial hypothesis discussed in the previous section: in the richer locations, it is easier to have a qualified staff "in house" that could develop its own technology or apply sophisticated foreign technology, whereas in the poorer states/regions, where one has less availability of qualified human capital, firms' technological needs will generally be obtained from their main suppliers and buyers or by contracting the services of engineering firms, universities and research institutes. Due to a greater number of significant results with respect to location by regions (variable 55), we decided to maintain this explanatory variable in the estimations of the final equation. By estimating the model for the selected clusters, we will be able to identify for which industries regional location plays an important role in defining their sources of technology.

- *Explanatory Variable 2 - Share of exports in firm's total revenues.* (12)

The correlation analysis confirms our initial hypothesis that in order to compete in the international markets industrial firms have to be as close as possible to the technological frontier used in their respective industries. All sources of technology had a significant positive correlation coefficient with respect to the share of exports in firm's total revenues. The only exception was University/research institute source of technology where, although the sign was the ones expected, it was not significant. The effectiveness of a science and technology policy will be enhanced if one identifies for each group of industries what would be the impact of an increase in exports in the importance of each source of technology.

- *Explanatory Variable 3 - Perceived exposure to foreign competition.* (10)

The degree of exposure to foreign competition was not a good indicator of firms' technological gap when correlations were calculated for the entire sample: none of these correlations was significant at .05 level. However, we decided to maintain this variable in the final estimations since the expected marginal effects for each specific cluster of industries, if significant, could give an indicator of the magnitude of this technological gap in each of them.

- *Explanatory Variable 4 - Perceived market structure.* (49-54)

The sample correlation coefficients of the market structure explanatory variables with respect to sources of technology were as expected in all cases where correlations were significant.[42] For

[42] They were not significant in the following cases: the correlation between the explanatory variable Suppliers' market power and dependent variables Firms' Own Technology and Suppliers and buyers; and between explanatory variables

their interpretation, please refer to the previous section.

Two of the correlations for which we had no prior expectations, although significant at .05 level, were not very strong: the correlation of .15 between firms' own technology and buyers's market power, and the correlation of -.08 between engineering firm and suppliers' market power.

Due to the importance of the market structure explanatory variables in the determination of sources of technology, we kept all the variables in the final estimations of the model. By identifying for each industry the relations between the distinct types of competitive forces and the sources of technology, it will be possible to define what should be the most adequate set of policies in both regulatory and science and technology spheres.

In this section, we selected the final explanatory variables to be included in the model. Before the estimation of the model for the entire data set, we will employ cluster analysis, in order to look whether one can identify some similar patterns among industries in the responses to the perceived importance of the main sources of technology.

Buyers' market power, Rivalry among producers and Velocity of introduction of new products and dependent variables University/research institute and Engineering firm.

VII.4 - Cluster Analysis: Identifying Similar Patterns Among Industries

The fourth dimension of this study that is analyzed in this chapter considers the determinants of firm/industry's main sources of technology. The five sources of technology, i.e., the dependent variables for which the models will be estimated, are the following.

1 - Firms' Own Technology;

2 - Suppliers/Buyers's Technology;

3 - University/Research Institute's Technology;

4 - Engineering Firm's Technology; and

5 - Foreign Technology.

The explanatory variables, selected by correlation and principal components analysis, to be included in each of the above five cases are listed below:

1 - Firm's location by Region. (55)

2 - Share of exports. (12)

3 - Exposure to foreign competition. (10)

4 - Suppliers' market power. (49)

5 - Buyers' market power. (50)

6 - Rivalry among producers. (51)

7 - Velocity of introduction of new products. (52)

8 - Potential entry of new competitors. (53)

9 - Potential entry of imported goods. (54)

Given the fact that there are five distinct sources of technology, we decided to build the industry clusters in function of their similarities in terms of their technological strategies. In ANNEX 3, one can find the results of clustering the five sources of technology by the average method, which was described in the methodological chapter. Based on the results of the cluster analysis, we defined three groups of industries that were very close in their response pattern. They are the following:

Cluster A: Leather products (Ind.# 10)
Textiles (Ind.# 15)
Food products (Ind.# 17)

Cluster B: Mining (Ind.# 1)
Nonmetallic mineral products (Ind.# 2)
Machinery (Ind.# 4)
Electrical and communications equipment (Ind.# 5)
Transportation equipment (Ind.# 6)
Wood products (Ind.# 7)
Paper products (Ind.# 8)
Rubber product (Ind.# 9)
Chemicals (Ind.# 11)
Pharmaceutical and veterinary products (Ind.# 12)
Plastic products (Ind.# 14)

Cluster C: Clothing and footwear (Ind.# 16)
Beverages (Ind.# 18)

We also estimated the equations for the Metal products industry (Ind.# 3), which was not included in none of the above clusters and has a sample large enough to allow its separate estimation.

In the next section, the results of the estimations of the ordered probit and logit models for all firms and for the selected clusters and industries will be presented.

VII.5 - Results of the Estimation of the Ordered Probit and Logit Models

One can find below a summary of the results of the ordered probit model estimated with all firms of the survey for each of the sources of technology.[43]

The hypothesis that all slopes of the nonconstant regressors are zero at .02 significance level is rejected for all estimations except Engineering Firms that is rejected at .1 significance level. The signs of the individually significant coefficients were the ones expected. The firms' predicted probability distributions with respect to the importance of the sources of technology were fairly close to the actual probabilities. One can see the latter and the marginal effects of the explanatory variables on these probability distributions in ANNEX 4.

[43] Similar results were obtained when estimating the ordered logit model. For the complete results of the estimations see ANNEX 4.

Table VII.7

Summary of the Results of the Ordered Logit Model Estimated for Sources of Technology

Explanatory Variables	Coefficients and Significance Level of Estimates[a]				
	Firms' Own Tech	Suppliers/Buyers	Univ./Res. Inst.	Engineering Firm	Foreign Tech.
Firm's location by region (55)	.0913 (.372)	-.2233 (.027)	-.1170 (.229)	-.2090 (.035)	.1463 (.153)
Share of exports in revenue (12)	.0464 (.167)	.0484 (.163)	.0164 (.639)	.0440 (.206)	.0351 (.321)
Compet. of imported products (10)	-.0598 (.368)	-.1709 (.011)	.0178 (.768)	-.0539 (.395)	-.1269 (.052)
Suppliers' market power (49)	.0260 (.667)	.0208 (.737)	-.1792 (.002)	-.1081 (.067)	.0798 (.205)
Buyers' market power (50)	.2685 (.000)	.0963 (.137)	.0843 (.187)	.0678 (.915)	.0708 (.272)
Rivalry among producers (51)	.1127 (.059)	.1869 (.003)	.0175 (.765)	-.0190 (.745)	.0170 (.780)
Veloc. of Introd. of new prod.(52	.0287 (.651)	.0714 (.261)	.1382 (.028)	.0659 (.295)	.3251 (.000)
Potential new competitors (53)	.0530 (.412)	.1368 (.030)	.0276 (.644)	.0607 (.333)	-.0662 (.289)
Pot. entry of imported goods (54)	.0752 (.284)	.0732 (.308)	-.1345 (.036)	-.0633 (.346)	.2395 (.000)
Overall Significance Level	.000460	.000008	.012478	.076381	.0000001
Number of Observations	605	599	600	596	602

a/ Significance levels in parenthesis.
Source: Author's own calculations.

The next table shows what are the predicted changes in the share of firms at the top tier of each source of technology in terms of its degree of importance, with one unit increase in the value of each explanatory variable when holding all others explanatory variables constant at their mean levels. For example, with one unit increase in the average opinion with respect to frequency of introduction of new products in the market, the participation of firms that would consider foreign sources of technology important or very important (5 and 6 in a scale from 1 to 6), would increase by 7.8 percentage points, i.e., the increase in market competition would lead firms to seek for more foreign technology. The same reaction, with a 5.4 percentage point increase in the top tier, would occur if the perception of potential entry of imported goods were to increase by one unit.

Table VII.8

Predicted Changes per Source of Technology in the Share of Firms at the Top Tier in Terms of Sources' Degree of Importance[a]

Explanatory Variable	Predicted Change in Each Source of Technology (%)				
	Firms' Own Tech	Sup./Buyers	Univ./Res. Inst.	Engineering Firm	Foreign Tech
Firm's location by region (55)	2.3	-5.2	-2.1	-3.1	3.5
Share of exports in revenue (12)	1.2	1.1	.3	.7	.8
Compet. of imported products (10)	-1.5	-4.0	.3	-.8	-3.0
Suppliers' market power (49)	.6	.5	-3.2	-1.6	1.9
Buyers' market power (50)	6.7	2.3	1.5	.1	1.7
Rivalry among producers (51)	2.8	4.4	.3	-.3	.4
Veloc. of Introd. of new prod.(52)	.7	1.6	2.5	1.0	7.8
Potential new competitors (53)	1.3	3.2	.5	.9	-1.6
Pot. entry of imported goods (54)	.6	1.7	-2.4	-.9	5.4

a/ Firms that consider the source of technology at levels of 5 and 6 in a scale of importance of the source from 1 to 6.
Source: Author's own calculations.

Braga and Willmore (1988), on their binomial logit model applied to a 1980 survey made by the University of São Paulo on 4,342 Brazilian firms, obtained some results that were compatible with ours in the case of similar dependent and explanatory variables. Their objective was to find out the importance of eleven explanatory variables on three types of technological activities, namely imports of technology, R&D and training, and rationalization of production lines. In their results, the probability of a firm to import technology would increase if there exists foreign capital participation, the size of the firm, firm's exports, and with higher industrial concentration; and would fall with firm's profits, effective protection and product diversification. In the case of R&D activities, the probability would increase if there exists foreign capital participation, the size of the firm, product diversification, exports, imports of technology and industrial concentration; and would fall with firm's profits, effective protection.

The complete results for the clusters and industries estimated separately are shown in ANNEX 4. The table below summarizes the individual significance level of the explanatory variable coefficients for each estimated equation. Based on these results, we can identify the clusters' and industries' specific characteristics by looking at which set of explanatory variables was significant in each case.

Table VII.9

Dimension 4: Determinants of Main Sources of Technology

Regressors' Significance Level[a]

Explanatory Variable	Firms' Own Tech.					Suppliers/Buyers					Univ./Res. Inst.					Engineering Firm					Foreign Tech.				
	All	A	B	C	M	All	A	B	C	M	All	A	B	C	M	All	A	B	C	M	All	A	B	C	M
Firm's location by region (55)						(a)		(b)		(c)				(a)	(a)	(a)				(b)	c	c			
Share of exports in revenue (12)	c		c		(c)	c		c								c	(b)	a		c					b
Compet. of imported products (10)						(a)		(a)							(c)					(c)	(a)		(a)		(c)
Suppliers' market power (49)					(b)			c			(a)	(a)				(b)					c			c	
Buyers' market power (50)	a	a	a			c		b		(c)	c	b	c												(c)
Rivalry among producers (51)	b					a	a	c				c		b											(c)
Veloc. of Introd. of new prod.(52)				c						c	a	(c)	c		a				c		a	a	a		a
Potential new competitors (53)						a		a												b					(b)
Pot. entry of imported goods (54)			c	(b)				c			(a)			c							a		a		a
Overall Significance Level	a	a	a	a		a	b	a	c		a	c		a	a	b			c	b	a	a	a		a

a/ The parenthesis indicates when the coefficient has a negative sign. Levels of significance a, b, and c means that the regressor is significant at the .05, .10, and .20 level, respectively.
Cluster A: Leather products; Textiles; and Food products.
Cluster B: Mining; Nonmetallic mineral products; Machinery; Electrical and communications equipment; Transportation equipment; Wood products; Paper products; Rubber products; Chemicals; Pharmaceutical and veterinary products; and Plastic products.
Cluster C: Clothing and footwear; and Beverages.
M is the Metal products industry.
Source: Author's own calculations.

VII.6 - Interpreting the Main Results

Based on the above table a number of interesting conclusions can be drawn. In the following paragraphs we will highlight some that we consider of particular importance.

Any industrial policy where special regional incentives are given should ponder the importance for each industry of its location in the determination of their main sources of technology. The explanatory variable "location by region" (55) was significant in explaining the importance of all sources except "firms' own technology development", which seems to be important in any region.[44] In "suppliers/buyers" technology development, for example, cluster B, which includes eleven industries and the Metal products industry had a significant negative correlation. This indicates that in order to locate firms from this cluster in the country's poorer regions, it would be important to concomitantly facilitate their access to suppliers/buyers' technologies. A successful industrial regional policy would have to take into account the most important mechanisms of technological diffusion characteristics of each region and group of industry.

The explanatory variable "share of exports in total revenue" (12) was significant in explaining the distinct importance of sources of technology in each industry. For the eleven industries in cluster B, the greater the export share in total revenue, the more a firm would tend to rely its own technology development, on suppliers/buyers's technology and on engineering firms technology. In the Metal industry, firms' own technology development would tend to lose importance while engineering firms and foreign technology development sources would play a greater role. The reasons behind that is that, in general, these industries face high costs of research and development and firms will need to be closer to international standards in order to remain competitive.

The greater the "suppliers' market power" (49), the less the

[44] For university/research institutes technology development, although the variable location by region was not significant at the overall level, it was significant for cluster C and the Metal products industry.

Metal industry will depend on its own technology development, and the less leather products, Textiles, and Food products industries (cluster A) will depend on university/research institute technology development. This is probably due to the technological requirements "imposed" by the suppliers. Meanwhile, for the eleven industries in cluster B the importance of suppliers/buyers' technology will increase, as well as the importance of foreign technology for Clothing and footwear, and Beverages industries (cluster C). With the opening of the economy, supplier's market power will tend to be reduced, reverting the tendencies exposed above.

Another interesting result can be observed for industries in the cluster B, with respect to explanatory variables competition of imported goods (10), potential entry of new competitors (53) and of imported goods (54). At the moment of the survey it seemed to exist a sort of "dividing waters" among the firms in these industries. On the one hand, under the high import barrier regime of the period, the higher the competition of imported products faced by certain firms, the less they would tend to rely in technologies from suppliers/ buyers and from abroad. On the other hand, the greater the firms' perception that potential new competitors and/or imported goods would come with the trade liberalization, the more they would tend to rely in the above sources of technology.

The liberalization policy will also affect most of the remaining explanatory variables, since it will be increasing the rivalry among producers (51), the velocity of introduction of new products (52), and so forth. The specific effects found in this analysis of the changes in those variables on each industry should be carefully taken into account in order to evaluate the adequate pace of the liberalization policy, and other supporting industrial and regulatory policies that should accompany it.

VII.7 - Summing Up

In this chapter, we analyzed the relationship between sources of technology and characteristics of firms and industries, such as their market structure, degree of openness to foreign markets, location and previous exposure to foreign competition. We also looked at the functioning of markets for technology, the current international techno-economic context and the Brazilian S&T program. This analysis found some relevant aspects that should be considered when defining the Brazilian science and technology policy and its legislation.

Among these relevant aspects is the fact that all five sources of technology discussed in this study are significantly positively correlated among each other, meaning that their complementarity is an important factor in defining the technology strategy and degree of competitiveness of a firm. Moreover, at least 25% of the firms in each industry gave an importance of 4 or more for all types of sources of technology, reinforcing the idea that all sources should be looked at thoughtfully by the government agencies responsible for the country's science and technology policy decisions. For example, when we looked at the entire sample of firms, the two least important sources of technology were "university and research institutes" and "engineering firms". Among the reasons for their relative smaller importance is the lack of better channels of communication between these institutions and the industrial sector, as well as a weak legislation on property rights that inhibits the markets for licensing of products and processes of production.

When analyzing the main determinants of firms/industries' sources of technology, we showed what are the most important sources of technology of each region and industry that a successful industrial regional policy would have to take into account.

With the Brazilian opening policy, the country will have to increase the firms' average share of exports in their total revenues. In order to compete in the international markets, industrial firms will have to be as close as possible to the technological frontier used on their respective industries. We identified for each group of industries, what will be the impact of an increase in exports in the degree of importance of the five sources of technology.

With the trade liberalization, the market structure faced by each industry will also be modified. We identified, for each industry, what are the relations between the distinct types of competitive forces and the sources of technology. This will contribute to define what should be the most adequate set of policies in both regulatory and science and technology spheres. As Gibbons (1995) states, "Brazilian S&T policy needs to be sensitive to the different knowledge requirements of its particular sectors."

(p.58)

Although one observes a globalization of production, the diffusion of technology becomes more and more one of the main strategic sources of competitive advantage. The Brazilian liberalization policy will affect the degree of competition of imported goods, the degree of rivalry among producers, the velocity of introduction of new products, and the changes in suppliers' and buyers' market power. We identified the specific effects of changes in these variables on industry's main sources of technology. These factors should also be carefully taken into account in order to evaluate the adequate pace of the liberalization policy, and the other supporting industrial policies that should accompany it, in order to guarantee an adequate insertion of the country in the world economy.

Based on the analysis of the probit model and in our assessment of the functioning of the markets for technology and the current international trends, we state below some additional recommendations that should be taken into account when defining Brazil's future S&T strategy and related regulatory framework:

a) One should attempt to reduce the costs and to optimize the domestic diffusion of core technologies in order to increase the overall productivity (competitiveness) of the country's industry;

b) To upgrade its technological capabilities since it is facing an increasing competition on its manufacturing and primary goods (domestically and exporting markets) from other emerging industrializing countries. S&T expenditures should attain about 2 percent of GDP instead of the current less than 1 percent;[45]

c) To adopt a "fast second" strategy by increasing domestic capacity of monitoring foreign R&D;[46]

d) To give incentives for a greater geographic concentration of members of interrelated industries (an industrial complex) taking into account their specificities. Such policy would increase their competitiveness through a greater exchange and share of information and services, as well enabling then to have a greater bargaining power with suppliers and clients;[47]

e) Firms should be selecting their own high technology niches compatible with country's capital constraints in order to create domestic market power and "virtuous" circles. The use of scarce resources in a concentrated manner in industries where dynamic economies of learning and R&D exist would allow the firms to attain international competitiveness in products where they will be facing smaller competition, hindering a

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[45] Gross fixed capital formation should be return to its 25 percent share of GDP from its current 20 percent of GDP. (Coutinho, 1994)

[46] As Gibbons (1985) states "...it seems to be possible for some firms to begin in the middle of the innovation cycle with the mature technologies of an established design configuration, and with a relatively low level of technical and marketing competence move on the become one of the leading players." (p.59)

[47] As Markusen (1995) states, "In the new trade theory, trade and gains from trade can arise independently of any pattern of comparative advantage (as traditionally understood) as firms exploit economies of scale and pursue strategies of product differentiation in an imperfectly competitive environment. The literature on geography and trade is a natural extension of this line of research, focussing on how industry agglomeration and regional differentiation can arise endogenously as a consequence of transport costs, market sizes, and the trade policy regime."

potential deterioration of the country's terms of trade. Possible examples for Brazil are in biotechnology, small precision machines, design industry, and appropriate technology;

f) To reduce the possibilities of facing abusive market power in strategic technologies. This strategy could be pursued in cooperation with other potentially threatened countries or through multilateral agreements;[48]

g) To create a regulatory framework that allows more licensing contracts and a greater integration of domestic and foreign firms. This is particularly the case in metallurgy, agro-industry, and auto industry;[49]

h) As in the case of Mercosul, one should attempt to reduce regional trade barriers in order to increase the size of markets, attracting foreign direct investments and increasing economies of specialization and learning;

i) To increase Government sharing of R&D risks;

j) To foster joint ventures in R&D. Technological cooperation and complementarity is a better strategy than pure technological transfers;[50]

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[48] One possible instrument is the use of Compulsory license, i.e., when a supplier of technology refuses to authorize licensing and the technology is not used in the country but is accessible.

[49] Unless Brazil possess a safe institutional environment for the diffusion of international technology, it will only be able to import the final products, if these are tradable goods. A safer institutional environment would also be an important condition for the creation of domestic R&D centers.

[50] Among the possible strategies is to create the conditions for Brazil's participation in international programs dealing with core technologies.

k) To seek an educational level, leading to a more qualified and flexible labor force and compatible with the requirements of a modern R&D system in order to achieve real technological improvement; and

l) To follow strategies leading to easier access to new technologies such as: i- installing R&D centers, purchasing small firms, and sending students and technicians to industrialized countries, ii- creating an industrial structure with a level of competition that allows to obtain frontier technology, iii- supporting firms' association for the development of technology, and iv- the appropriate environment to attract foreign capital of firms with new technologies and management techniques through direct investment and joint ventures.

All policy instruments to be used must be properly synchronized. They encompass policy areas such as trade regime (tariff and non-tariff barriers), science and technology (e.g., risk share, training, financing, technology diffusion), foreign capital (e.g., subsidies, taxes, remittances), foreign financing instruments (e.g., commercial papers, pre-payment of exports, floating rate notes), and regulatory framework. With respect to the latter, the country still needs to establish regulations for patents, property rights, anti-trust and anti-dumping laws as well as institutional strengthening of the agencies responsible for their enforcement. Finally, we must mention also here that the global macroeconomic environment (savings rates, costs of capital formation, education of the labor force, exchange rates, interest rates, inflation, etc.) is also fundamental in determining the performance of the domestic industry.

As Schwartzman (1995) states, the Brazilian S&T policy for the end of this century should

> "...implement tasks that are apparently in contradiction: to stimulate the freedom, initiative and creativity of the researcher, while establishing strong links between their work and the requirements of the economy, the educational system and of society as a whole... This requires a competitive environment based on public incentives and private opportunities that rewards achievement, increases the costs of complacency and underachievement, and gears a substantial part of the R&D resources toward a few important and strategic selected goals." p.30

With this chapter, we completed the analysis of the four dimensions initially proposed to evaluate the problems faced by the Brazilian industry with the trade liberalization policy and changes in the regulatory regime. In the next chapter we will summarize the main conclusions of this study and propose some general considerations that should be taken into account in the current state of the Brazilian economy, in particular with respect to trade liberalization and the required supporting industrial and science and technology policies that would be appropriate to accompany it.

VIII - CONCLUSIONS

The prospects of the Brazilian industry depend on the coordination of various difficult economic tasks that are currently being undertaken simultaneously, in particular, economic stabilization, changes in trade regime, deregulation and privatization. Industry's specificities and the way markets for technology function are among the factors to be taken into account when defining the configuration, sequencing and pace of implementation of these major reforms as well as the country's industrial and science and technology programs. Such strategy could help to minimize the social costs of these adjustments, to warrant the basic conditions for sustainable economic growth, and to improve Brazil's future insertion in a fast changing world economy.

In this study we attempted to cover a significant portion of these concerns. Among our general recommendations are the need to attain price stability without submitting the economy to prolonged periods of large real exchange rates overvaluation and high real interest rates, and to seek higher gross fixed investments (at around 25 percent of GDP) through, in particular, the availability of long term credit lines. The maintenance of a more stable economy (inflation, exchange rate, interest rates); a more coherent, credible and less volatile set of rules (trade regime, property rights, patent laws, foreign capital, etc.); and well defined science and technology, as well as training and education programs, are fundamental to the successful achievement of Brazil's socio-economic goals.

The issues that we considered of particular importance to be analyzed in the current context of the Brazilian industry were related to the determinants of the degree of competitiveness and international insertion of firms/industries; the types of adjustment needed for the firms/industries in this new environment; and the process of flow of new technologies and whether domestic technological capabilities are required in order for firms to survive with the opening of their domestic markets. Our analysis of the CNI-1991 industrial survey showed the substantial intraindustry and interindustry variations in the responses. These variations highlight the existence of important specific characteristics that are relevant in determining their performance at both levels of aggregation.

The methodology of analysis of these distinct dimensions, based in the estimation of ordered probit models using survey data, gave us insights in understanding the determinants of performance of firms and industries in the Brazilian economy, given their past strategies and government policies. This is of a great importance at the present moment given the new economic environment faced by the Brazilian firms in the 1990s, and the lack of a more detailed set of industrial and science and technology indicators. In general, as we pointed out along the chapters of this study, our results were compatible with the distinct industries' responses to the economic reforms implemented during the first half of the 1990s. Nevertheless, we strongly support here the importance of creating an updated industrial and science and technology information system that would allow a stronger foundation in the formulation of firms' strategic decisions and in society's debate on the direction of future economic reforms.

By the early 1990s, there was already a strong demand for a deeper reevaluation of the role of the state and for a modernization of the Brazilian economy. This has led to a significant process of liberalization, that has encompassed a larger economic role for the private sector and a greater opening of the economy. Among the main deregulatory achievements are several measures towards the simplification of economic controls and easing of entry barriers.

It was in the import regime that we observed the most striking changes in the early 1990s. These trade reforms followed a predetermined sequencing starting by the abolition of most "special import regimes"; followed by the list of forbidden imports being substituted by high tariffs; quantitative restrictions also replaced by tariffs, with the issuing of import licenses becoming an automatic procedure; and the implementation of a preannounced schedule of tariffs reduction with the country's mean tariff being reduced from 25.3% in 1991 to 14.2% in 1994. During the first two years, however, the larger decreases in tariffs were concentrated in intermediate and capital goods, providing a temporary shield for the domestic consumer industry in order for its preparation for greater market competition.

We also pointed out that there exist potential problems that can arise from the implementation of a trade liberalization policy in an economy that still faces major domestic imbalances such as the Brazilian chronic inflation. The Brazilian experience in the second half of the 1980s and early 1990s has shown that the use of the exchange rate as a nominal anchor to inflation can have perverse effects on the external trade performance. The more recent example with the Real Plan led to a huge trade deficit mainly caused by a boom in imports. The government has attempted to counterbalance the trade balance shift by temporarily increasing certain tariffs and imposing import quantity restrictions. However, these measures are generating uncertainties about the sustainability of the trade liberalization program. As long as there is no permanent solution for the inflationary problem, expectations of future temporary trade barriers will remain, disrupting needed future investments in the country.

Our study identified the presence of market distortions in some industries caused by trade restrictions that, with the greater liberalization of the economy, will lead to greater specialization of the production lines of these industries. Notwithstanding, in the case of high technology industries, one can not discard the possibility that this result could indicate the presence of some potentially successful lines of production that are still in an "undeveloped" stage and could be eliminated.

Moreover, our results indicate that import protection by itself does not guarantee the development of a country's competitive industry. The reasons for such failure can be a combination of several factors: expectations that protectionist barriers will not be eliminated as programmed, a credibility problem; lack of the necessary time to "catch up"; high costs of inputs and equipments due to trade barriers during the protection period; a domestic market not sufficiently large to attain ideal scales of production; and difficulties to export. Policy makers should take a broader view of all these possible factors affecting the prospects of an industry before defining any trade/industrial policy. In addition, our results have shown that for a successful trade liberalization policy to occur, an effort to increase firms' exports would be required not only in order to equilibrate the trade balance, but also as an instrument to improve their preparedness to face a greater competition in the domestic market. The export performance of the early 1990s corroborated this result, as the share of exports in total production increased from 9.2 percent in 1990 to 13.2 percent in 1994, showing a more aggressive strategy towards increased competitiveness.

In our analysis we were able to identify for which industries certain economic conditions were the most effective in improving the share of exports in firms' total revenues. Among these economic conditions were policies leading to a reduction on suppliers' market power, the liberalization of imports of informatic goods, the availability of financial credits, easier imports from international markets, a more stable and realistic real exchange rate, the reduction of main obstacles to export (in particular harbor costs), and regional incentives and government direct investment in less developed areas of the country.

We examined the determinants of distinct adjustment options that could be undertaken by each firm/industry in reaction to Brazilian trade liberalization program that began in the early 1990s. These adjustments are not only an indicator of their main current deficiencies in face of the liberalization of the economy, but also gave a better idea of their future situation in terms of capital ownership, degree of vertical integration, diversification of production, and capital and human resources investments. By manipulating the main determinants of the adjustments decisions, among them, property rights regime, science and technology policies, the velocity of trade liberalization, industries market structures and, in particular import restrictions on industry's modernization, one could affect the future profile of Brazilian industry and its insertion in the world economy. Our results have shown that these determinants have distinct degrees of importance for each industry, a crucial factor to be taken into account when defining the country's economic policies and regulations.

In our analysis of the relationships between sources of technology and characteristics of firms and industries, such as their market structure, degree of openness to foreign markets, location and previous exposure to foreign competition, we also looked at the functioning of markets for technology, the current international techno-economic context and the Brazilian S&T program. We found some relevant aspects that should be considered when defining the Brazilian science and technology policy and its legislation. Among these relevant aspects is the fact that all five sources of technology discussed in this study are significantly positively correlated among each other, meaning that their complementarity is an important factor in defining the technology strategy and degree of competitiveness of a firm. The relative smaller importance of universities, research institutes and engineering firms as sources of technology, seems to be caused by the lack of better channels of communication between these institutions and the industrial sector, as well as a weak legislation on property rights that inhibits the markets for licensing of products and processes of production.

With the Brazilian opening policy, as we mentioned before, the country should attempt to increase the firms' average share of exports in their total revenues. In order to compete in the international markets, industrial firms will have to be as close as possible to the technological frontier used on their respective industries. We identified for each group of industries what will be the impact of an increase in exports in the importance of each of the five sources of technology. We also identified, for each industry, what are the relations between distinct types of competitive forces and sources of technology.

Although one observes a globalization of production, the diffusion of technology becomes more and more one of the main strategic sources of competitive advantage. The Brazilian liberalization policy will affect the degree of competition of imported goods, the degree of rivalry among producers, the velocity of introduction of new products, and the changes in suppliers' and buyers' market power. We identified the specific effects of changes in these variables on industry's main sources of technology. These factors should also be carefully taken into account in order to evaluate the adequate pace of the liberalization policy, and the other supporting industrial policies that should accompany it, in order to guarantee an adequate insertion of the country in the world economy.

Due to the specific characteristics of markets for technology, we observe the existence of a dichotomy between "static" or allocative efficiency (diffusion) and "dynamic" efficiency (innovation). This dichotomy between innovation and diffusion processes makes the definition of the most appropriate institutional environment more difficult. Moreover, the externalities generated by market failures together with the presence of transactions costs provides a case for intervention in markets for technology in order to improve the economy's allocative efficiency. Another motive supporting market intervention is the uneven distribution of developers and consumers of technology among countries leading to "virtuous" and "vicious" circles of technology advance, respectively, given their distinct dynamic potential in terms of economies of scale, technical progress, and learning by doing.

Government policies will affect the governance structures and the pace under which technology will be generated and diffused. The government can influence the costs of domestic firms in absorbing foreign technology. Moreover, the lower the potential costs for domestic firms to develop new competitive technologies, the smaller are the rents that foreign developers can extract from market sales or from direct use of their technologies.

Among a country's main objectives should be the maximization of its expected long run economic growth, i.e., the maximization of its expected returns on the process of generation, exchange and use of technologies. At the domestic level, it should provide incentives to accelerate the process of technological innovation and diffusion within the economy. At the international level, the main objective should be to minimize the costs and to accelerate the process of absorption of imported technology, as well as to maximize the economic returns of these technologies, through international transactions of technologies themselves and/or of their final products.

Higher and sustainable economic growth is associated with the implementation of a competitive industrial strategy, where the increase of the Brazilian insertion in the world economy plays a fundamental role. Historically, economic catching-up effort comes with technological catching-up in the new and most dynamic technologies, irrespective of the initial patterns of comparative advantages, specialization and market-generated signals. In order for an industrializing country not to permanently face the distress of excess world supplies of primary and low-technology products, a possible alternative would be to promote specific high-technology sectors.

With the Brazilian trade liberalization, a particular concern of ours is that the country could end up loosing a good part of its domestic technological capabilities, since in many cases import of foreign technologies would be, at least in the first moment, a cheaper way to obtain it. With the trade liberalization that began in the early 1990s, we observed a tendency to a reduction in domestic R&D expenditures at firms' level, which was considered a more pragmatic strategy, but with risks of loosing technological capability in the longer term, becoming more and more dependent on foreign sources of technology that sometimes have a very discretionary accessibility determined either by the suppliers' own strategic decisions, or by security reasons of industrialized countries' governments. In other words, although one observes a globalization of production, the diffusion of technology becomes more and more one of the main strategic sources of competitive advantage.

Based on the analysis of the probit model and in our assessment of the functioning of the markets for technology and the current international trends, we made an extensive list of recommendations that should be taken into account when defining Brazil's future S&T strategy and related regulatory framework.

During the last two years, when a great number of reforms have already advanced significantly and the Brazilian economy started to recover, we began to see a greater capacity of supply response of an industrial sector in the process of modernization. During these two years, productivity grew by more than 10 percent per year, with output increases being responsible for about three quarters of this improvement. During this period, in spite of the increasing domestic demand and the considerable appreciation of the real effective exchange, the remarkable export performance of the Brazilian industry can be an indicator of a distinct market strategy as well as of its increased competitiveness.

The Brazilian economic reforms are not yet completed. Important areas that remain to be privatized are in mining, oil, telecommunications and electricity. Moreover, among the main issues that will certainly be included in the deregulation agenda of the coming years are the completion of the trade-reform; the privatization of public enterprises; the legislation on foreign-exchange transactions, foreign investment and technology transfer; and the modifications in the intellectual property rights legislation. The future of the deregulatory process, however, remains uncertain given the difficult and sensitive political debates over its future direction. There still remains a considerable amount of government intervention in the economy through regulation, control of public enterprises' decisions, and it is not yet entirely defined how far should go the role of government in shaping industrial policies. In addition, the Brazilian regulatory system has a weak institutional structure and still lacks experience on how to regulate. This situation also generates uncertainties that could be hindering higher levels of private investment in the Brazilian economy.

Finally, we would like to point out that regulatory reforms are processes that never end. If, on the one hand, regulations must be stable in order to give confidence for private investments, on the other hand, they permanently have to adapt to the constantly transforming international economic environment. Moreover, there is no reason to believe that the lines between what society wants to leave private and what society wants to make public will remain constant over time. A central part of society's economic problem, then, is the need to continuously draw and redraw these boundary lines.

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ANNEX 1 - VARIABLES OF CNI'S SURVEY

ANNEX 1 - VARIABLES OF CNI'S SURVEY

01 INDUSTRY - TWO DIGITS CLASSIFICATION OF IBGE[1]

01	01	Mining
01	02	Nonmetallic mineral products
01	03	Metal Products
01	04	Machinery
01	05	Electrical and communications equipment
01	06	Transportation equipment
01	07	Wood products
01	08	Paper products
01	09	Rubber products
01	10	Leather products
01	11	Chemicals
01	12	Pharmaceutical and veterinary products
01	13	Perfumes, soaps and candles
01	14	Plastic products
01	15	Textiles
01	16	Clothing and footwear
01	17	Food products
01	18	Beverages
01	19	Tobacco products
01	20	Printing and publishing

02 INDUSTRY SUBGROUP - Four digits classification of IBGE

03 INDUSTRY - Two digits classification of Gazeta Mercantil

04 INDUSTRY SUBGROUP - Four digits classification of Gazeta Mercantil

05 STATES (classified in 6 groups based on their GDP: 1- the poorest states, 6- the richest states)

05	01	Acre, Paraiba, Piauí
05	02	Alagoas, Amazonas, Sergipe, Rondônia
05	03	Ceará, Espírito Santo, Maranhão, Rio Grande do Norte
05	04	Distrito Federal, Goiás, Mato Grosso, Pará
05	05	Bahia, Paraná, Pernambuco, Santa Catarina
05	06	Minas Gerais, Rio de Janeiro, Rio Grande do Sul, São Paulo

[1] Fundação Instituto Brasileiro de Geografia e Estatística.

06 NUMBER OF EMPLOYEES

06	01	From 0 to 249
06	02	From 250 to 499
06	03	From 500 to 999
06	04	From 1.000 to 2.499
06	05	From 2.500 to 4.999
06	06	From 5.000 to 99.999

07 TOTAL REVENUES

07	01	From 0 to 6.000
07	02	From 6.001 to 20.000
07	03	From 20.001 to 99.999

08 ORIGIN OF CAPITAL (not disclosed at firm level)

09 VELOCITY AND RHYTHM OF IMPLEMENTATION OF COMMERCIAL LIBERALIZATION IN THE INDUSTRY (1-slow, 6-fast)

10 WHETHER THE INDUSTRY ALREADY EXPERIENCE THE COMPETITION OF IMPORTED PRODUCTS (1-weak,6-strong)

11 HOW PREPARED IS THE FIRM TO FACE COMPETITION OF IMPORTED PRODUCTS (1-weak, 6-strong)

12 AVERAGE SHARE OF EXPORTS IN TOTAL REVENUE.

12	01	0 to 5%
12	02	6 to 10%
12	03	11 to 15%
12	04	16 to 20%
12	05	21 to 25%
12	06	26 to 30%
12	07	31 to 35%
12	08	More than 35%

13 IMPACT OF OPENING POLICY ON INVESTMENT DECISION

13	01	Positive: Induced investment
13	02	No impact
13	03	Negative: Reduced investment

14 DECISION OF ADAPTATION AND ADJUSTMENT IN THE INDUSTRY AFTER IMPORT LIBERALIZATION POLICY (1-weak, 6-strong)

QUESTIONS 15-27: WHICH ADJUSTMENT OPTIONS WILL BE MORE FREQUENT IN YOUR INDUSTRY WITH THE LIBERALIZATION POLICY ? (1-not frequent, 6-very frequent)

15 ACQUISITION OF NEW MACHINERY AND EQUIPMENTS
16 RATIONALIZATION OF PRODUCTION LINES
17 REDUCTION OF DEGREE OF VERTICAL INTEGRATION
18 INCREASE IN IMPORTS OF COMPONENTS
19 SUBSTITUTION OF OWN PRODUCTION FOR IMPORTED PRODUCTS
20 REDUCTION OF DEGREE OF DIVERSIFICATION OF LINE OF PRODUCTION
21 ASSOCIATION WITH MULTINATIONAL ENTERPRISES
22 MERGERS AND CONSOLIDATIONS
23 INCREASE IN TECHNOLOGY INVESTMENTS
24 INCREASE OF PURCHASE OF FOREIGN TECH./PRODUCTS LICENSING
25 EXTENSION OF HUMAN RESOURCES TRAINING
26 CREATION/EXPANSION OF QUALITY CONTROL PROGRAMS
27 RENEGOTIATION OF SUPPLIERS PRICES

28 IN WHAT MEASURE YOUR DECISION TO NOT SUBSTITUTE LOCAL MACHINERY AND COMPONENTS SUPPLIERS BY IMPORTS IS INFLUENCED BY YOUR EVALUATION WITH RESPECT TO THE RISKS OF INTERRUPTION OF THE PROCESS OF COMMERCIAL LIBERALIZATION (1-little influenced, 6-very influenced)

29 EVALUATION OF CURRENT IMPORT RESTRICTIONS OF INFORMATIC GOODS ON THE MODERNIZATION OF YOUR INDUSTRY (1-little importance, 6-very important)

QUESTIONS 30-37: OBSTACLES TO THE INTENSIFICATION OF EXPORTS (1-little importance, 6-very important)

30 EXCHANGE RATE
31 FINANCING TO FOREIGN SALES
32 FINANCING OF PRODUCTION
33 BUREAUCRATIC OBSTACLES
34 HARBOR COSTS
35 TRANSPORT COSTS
36 CREDIT INSURANCE
37 ESPECIAL INCENTIVES

QUESTIONS 38-43: CURRENT NEEDS FOR IMPROVEMENT IN THE RATIONALIZATION OF PRODUCTION OF YOUR INDUSTRY ? (1-little necessary, 6-strongly necessary)

38 BETTER QUALITY CONTROL
39 BETTER MANAGEMENT OF STOCK
40 BETTER PRODUCT
41 BETTER PRODUCTION PROCESS
42 BETTER PACKAGING
43 BETTER DISTRIBUTION

QUESTIONS 44-48: THE ROLE OF THE FOLLOWING SOURCES IN THE FULFILLMENT OF YOUR TECHNOLOGICAL NEEDS? (1-little importance, 6-very important)

44 FIRM'S OWN TECHNOLOGY DEVELOPMENT
45 SUPPLIERS/BUYERS TECHNOLOGY DEVELOPMENT
46 UNIVERSITY/RESEARCH INSTITUTES TECHNOLOGY DEVELOPMENT
47 ENGINEERING FIRMS TECHNOLOGY DEVELOPMENT
48 FOREIGN TECHNOLOGY - TECHNOLOGY DEVELOPED ABROAD

QUESTIONS 49-54: MARKET STRUCTURE - HOW DO YOU EVALUATE IN YOUR INDUSTRY (1-very low, 6-very high)

49 SUPPLIERS MARKET POWER
50 BUYERS MARKET POWER
51 RIVALRY AMONG PRODUCERS IN THE INDUSTRY
52 VELOCITY OF INTRODUCTION OF NEW PRODUCTS
53 POTENTIAL ENTRY OF NEW COMPETITORS
54 POTENTIAL ENTRY OF IMPORTED GOODS

55 REGION (in ascending order of regions' GDP)

55 01 North (AC,AM,PA,RO)
55 02 Mid-West (DF,GO,MT)
55 03 North-East (AL,BA,CE,MA,PB,PE,PI,RN,SE)
55 04 South (RS, PR, SC)
55 05 South-East (SP, RJ, MG, ES)

ANNEX 2 - RESULTS OF PRINCIPAL COMPONENTS ANALYSIS

ANNEX 2 - RESULTS OF PRINCIPAL COMPONENTS ANALYSIS

Contents:

Adjustment Options

Principal Components Analysis:
Variables: 19,20,18,16,25,26,24,23,15,22

Component Number	Percent of Variance	Cumulative Percentage
1	36.79750	36.79750
2	18.21935	55.01685
3	9.25611	64.27296
4	8.65245	72.92542
5	6.52104	79.44646
6	5.47815	84.92461
7	4.62034	89.54495
8	4.17007	93.71501
9	3.87899	97.59400
10	2.40600	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
19	0.133004	-0.595596	-0.19117
20	0.244595	-0.333001	-0.45299
18	0.231151	-0.384504	-0.0538974
16	0.356471	0.06721	-0.426703
25	0.409163	0.23784	-2.08652E-3
26	0.392937	0.267811	-0.0214688
24	0.333948	-0.208775	0.494301
23	0.366721	0.294165	0.130881
15	0.336911	0.177125	-0.111672
22	0.246275	-0.303696	0.546694

Adjustment Options (cont.)

Principal Components Analysis:
Variables: 19,20,18,17

Component Number	Percent of Variance	Cumulative Percentage
1	52.38227	52.38227
2	18.82062	71.20289
3	16.01510	87.21799
4	12.78201	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
19	0.540808	0.123425	-0.410183
20	0.47765	-0.681036	-0.343934
18	0.482454	0.703229	-0.0664377
17	0.496603	-0.16256	0.842048

Principal Components Analysis:
Variables: 16,25,26

Component Number	Percent of Variance	Cumulative Percentage
1	71.61952	71.61952
2	19.97446	91.59398
3	8.40602	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
16	0.509614	0.857702	-0.0681252
25	0.602676	-0.412352	-0.683189
26	0.614064	-0.307105	0.727057

Adjustment Options (cont.)

Principal Components Analysis:
Variables: 24,23,15

Component Number	Percent of Variance	Cumulative Percentage
1	58.52006	58.52006
2	24.77509	83.29515
3	16.70485	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
24	0.600033	-0.441542	0.667084
23	0.619216	-0.271605	-0.736751
15	0.50649	0.855144	0.110438

Principal Components Analysis:
Variables: 21,22,27

Component Number	Percent of Variance	Cumulative Percentage
1	59.45383	59.45383
2	29.64790	89.10173
3	10.89827	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
21	0.662298	-0.246222	0.707627
22	0.661594	-0.25108	-0.706578
27	0.351646	0.936127	-3.39051E-3

Rationalization of Production

Principal Components Analysis:
Variables: 38,39,40,41,42,43.

Component Number	Percent of Variance	Cumulative Percentage
1	51.73748	51.73748
2	15.28749	67.02496
3	10.78196	77.80693
4	8.19840	86.00533
5	7.40493	93.41026
6	6.58974	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
38	0.417606	-0.352181	-0.0622393
39	0.389414	-0.155404	-0.819906
40	0.447905	-0.188627	0.247799
41	0.411484	-0.382479	0.434266
42	0.397259	0.535979	0.2477
43	0.382372	0.618607	-0.11196

Market Structure

Principal Components Analysis:
Variables: 49,50,51,52,53,54.

Component Number	Percent of Variance	Cumulative Percentage
1	31.23575	31.23575
2	18.63446	49.87021
3	15.36309	65.23330
4	14.48620	79.71950
5	11.25303	90.97253
6	9.02747	100.00000

Variables' Weight:

Variable	1st PC	2nd PC	3rd PC
49	0.159494	-0.54085	0.817677
50	0.222081	-0.581805	-0.44749
51	0.391727	-0.376462	-0.245227
52	0.523032	0.0559842	-0.148397
53	0.538[illegible]95	0.343722	0.0957227
54	0.456466	0.325546	0.199591

Obstacles to Export

Principal Components Analysis
Variables: 30-37.

Component Number	Percent of Variance	Cumulative Percentage
1	45.74971	45.74971
2	15.44187	61.19158
3	9.99588	71.18746
4	8.52797	79.71542
5	7.28939	87.00482
6	5.82054	92.82536
7	4.57775	97.40311
8	2.59689	100.00000

Variables' weight:

Variable	1st PC	2nd PC	3rd PC
30	0.297435	-0.0731685	-0.859769
31	0.328469	-0.556877	-0.0584387
32	0.331864	-0.456179	0.113357
33	0.358109	0.177578	0.227306
34	0.390009	0.458527	-0.0417218
35	0.382679	0.464003	-0.0115541
36	0.37887	-0.133976	0.435798
37	0.350959	-0.0374902	0.0327207

Sources of Technology

Principal Components Analysis
Variables: 44-48

Component Number	Percent of Variance	Cumulative Percentage
1	39.26832	39.26832
2	20.27639	59.54471
3	18.52327	78.06798
4	14.48732	92.55529
5	7.44471	100.00000

Variables' weight:

Variable	1st PC	2nd PC	3rd PC
44 (OF)	0.27778	0.525127	-0.724424
45 (SB)	0.462345	0.188838	-0.0674758
46 (UR)	0.588704	-0.303159	-0.0205756
47 (EF)	0.565658	-0.348124	0.192329
48 (FT)	0.206238	0.689555	0.658212

ANNEX 3 - Results of Cluster Analysis

ANNEX 3 - Results of Cluster Analysis

Contents:

Dimension 1

Results of Clustering by Seeded Method

Variables: All

Industry	Cluster	Cluster	Frequency	Percentage	Seed
1	1	1	3	15.7895	1
2	2	2	2	10.5263	2
3	3	3	3	15.7895	3
4	4	4	3	15.7895	4
5	5	5	4	21.0526	5
6	6	6	4	21.0526	6
7	1				
8	5				
9	5				
10	4				
11	3				
12	2				
13	6				
14	3				
15	5				
16	6				
17	6				
18	4				
20	1				

Dimension 1 (cont.)

Variables: 10,19,16,24,38. (expected negative coefficients)

Industry	Cluster
1	1
2	2
3	3
4	4
5	5
6	6
7	1
8	4
9	6
10	5
11	3
12	4
13	6
14	3
15	2
16	6
17	6
18	4
20	1

Cluster	Frequency	Percentage	Seed
1	3	15.7895	1
2	2	10.5263	2
3	3	15.7895	3
4	4	21.0526	4
5	2	10.5263	5
6	5	26.3158	6

Variables: 12,51. (expected positive coefficients)

Industry	Cluster
1	1
2	2
3	3
4	4
5	5
6	6
7	2
8	5
9	4
10	1
11	2
12	1
13	3
14	2
15	5
16	3
17	3
18	2
20	5

Cluster	Frequency	Percentage	Seed
1	3	15.7895	1
2	5	26.3158	2
3	4	21.0526	3
4	2	10.5263	4
5	4	21.0526	5
6	1	5.2632	6

Dimension 2

Results of Clustering by Seeded Method

Variables: All (55,14,30,31,34,49)

Industry	Cluster	Cluster	Frequency	Percentage	Seed
1	1	1	2	10.5263	1
2	2	2	3	15.7895	2
3	3	3	3	15.7895	3
4	4	4	3	15.7895	4
5	5	5	7	36.8421	5
6	6	6	1	5.2632	6
7	5				
8	4				
9	4				
10	5				
11	3				
12	2				
13	5				
14	5				
15	5				
16	3				
17	5				
18	2				
20	1				

Dimension 2 (cont.)

Variables: 14,30,31,34 (expected positive coefficients)

Industry	Cluster	Cluster	Frequency	Percentage	Seed
1	1	1	4	21.0526	1
2	2	2	4	21.0526	2
3	3	3	2	10.5263	3
4	4	4	4	21.0526	4
5	5	5	2	10.5263	5
6	6	6	3	15.7895	6
7	5				
8	2				
9	4				
10	1				
11	6				
12	2				
13	2				
14	6				
15	4				
16	3				
17	1				
18	4				
20	1				

Variables: 55,49 (expected negative coefficients)

Industry	Cluster	Cluster	Frequency	Percentage	Seed
1	1	1	1	5.2632	1
2	2	2	3	15.7895	2
3	3	3	2	10.5263	3
4	4	4	2	10.5263	4
5	5	5	9	47.3684	5
6	6	6	2	10.5263	6
7	5				
8	4				
9	3				
10	5				
11	5				
12	2				
13	5				
14	5				
15	5				
16	5				
17	5				
18	2				
20	6				

Dimension 3

Results of Clustering by Average Method

Variables: Sources of Technology (44-48)

Industry	Cluster	Cluster	Frequency	Percentage	Seed
1	1	1	11	57.8947	1
2	1	2	1	5.2632	2
3	2	3	3	15.7895	3
4	1	4	1	5.2632	4
5	1	5	2	10.5263	5
6	1	6	1	5.2632	6
7	1				
8	1				
9	1				
10	3				
11	1				
12	1				
13	4				
14	1				
15	3				
16	5				
17	3				
18	5				
20	6				

Dimension 4

Results of Clustering by Average Method

Variables: Adjsutments Options (19,16,24,21)

Industry	Cluster	Cluster	Frequency	Percentage
1	1	1	2	10.5263
2	2	2	1	5.2632
3	3	3	12	63.1579
4	3	4	2	10.5263
5	3	5	1	5.2632
6	3	6	1	5.2632
7	1			
8	3			
9	3			
10	3			
11	3			
12	3			
13	3			
14	3			
15	4			
16	4			
17	5			
18	3			
20	6			

ANNEX 4 - RESULTS OF ORDERED PROBIT AND LOGIT MODELS

ANNEX 4 - RESULTS OF ORDERED PROBIT AND LOGIT MODELS

Contents:

Dimension 1: Determinants of a Firm/Industry Preparation for Foreign Competition

All Firms

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood.............	-939.52
Restricted (Slopes=0) Log-L.	-978.77
Chi-Squared (7)............	78.517
Significance Level..........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	40.	.06838	4	98.	.16752			
1	127.	.21709	5	36.	.06154			
2	139.	.23761						
3	145.	.24786						

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	2.9364	.2441	12.031	.00000		
X10	-.12658	.3053E-01	-4.147	.00003	2.4530	1.4268
X12	.86433E-01	.1861E-01	4.645	.00000	2.4803	2.1700
X16	-.46489E-01	.3276E-01	-1.419	.15585	4.5402	1.2144
X19	-.10255	.3459E-01	-2.965	.00303	2.4444	1.3602
X24	-.69323E-01	.3144E-01	-2.205	.02745	3.7504	1.4883
X38	-.12293	.3426E-01	-3.589	.00033	4.7094	1.1796
X53	.94939E-02	.3498E-01	.271	.78606	3.3521	1.3030
MU(1)	.94658	.7572E-01	12.502	.00000		
MU(2)	1.6138	.8292E-01	19.461	.00000		
MU(3)	2.3645	.9160E-01	25.814	.00000		
MU(4)	3.2586	.1148	28.380	.00000		

Predicted Probablities:

	1
ROW 1	.580468E-01
ROW 2	.208002
ROW 3	.250851
ROW 4	.269244
ROW 5	.168080
ROW 6	.457764E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.146927E-01	-.100323E-01	.539597E-02	.119030E-01	.804633E-02	.142688E-01	-.110195E-02
ROW 2	.268525E-01	-.183351E-01	.986171E-02	.217540E-01	.147055E-01	.260778E-01	-.201394E-02
ROW 3	.890955E-02	-.608352E-02	.327208E-02	.721790E-02	.487924E-02	.865252E-02	-.668217E-03
ROW 4	-.135824E-01	.927419E-02	-.498821E-02	-.110035E-01	-.743829E-02	-.131906E-01	.101868E-02
ROW 5	-.247075E-01	.168705E-01	-.907396E-02	-.200163E-01	-.135309E-01	-.239947E-01	.185307E-02
ROW 6	-.121648E-01	.830624E-02	-.446759E-02	-.985509E-02	-.666195E-02	-.118139E-01	.912362E-03

Ordered Probit Model: Cluster A (Ind. 1, 7, and 20)

Maximum Likelihood Estimates	
Log-Likelihood..............	-40.781
Restricted (Slopes=0) Log-L.	-51.170
Chi-Squared (7)............	20.779
Significance Level..........	.41119E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	5.	.16667	4	2.	.06667			
1	6.	.20000	5	3.	.10000			
2	6.	.20000						
3	8.	.26667						

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	4.2471	1.636	2.595	.00945		
X10	-.38348	.2651	-1.447	.14799	2.0667	1.2299
X12	.25986	.1767	1.471	.14142	2.9667	2.6061
X16	.11137	.2602	.428	.66861	4.7333	1.1121
X19	-.11716	.3199	-.366	.71417	1.9333	1.1725
X24	-.90682E-01	.2730	-.332	.73972	3.5333	1.4559
X38	-.46651	.2982	-1.565	.11768	4.7000	1.2360
X51	-.12851	.2574	-.499	.61765	4.4333	1.2780
MU(1)	.92216	.5004	1.843	.06535		
MU(2)	1.6465	.5259	3.131	.00174		
MU(3)	2.7977	.7873	3.554	.00038		
MU(4)	3.3377	1.006	3.318	.00091		

Predicted Probablities:

		1
ROW	1	.744506E-01
ROW	2	.226641
ROW	3	.279359
ROW	4	.331723
ROW	5	.587322E-01
ROW	6	.290943E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
1	.539804E-01	-.365782E-01	-.156768E-01	.164917E-01	.127647E-01	.656676E-01	.180890E-01
2	.795727E-01	-.539201E-01	-.231092E-01	.243105E-01	.188165E-01	.968009E-01	.266650E-01
3	.163132E-01	-.110541E-01	-.473760E-02	.498389E-02	.385756E-02	.198451E-01	.546659E-02
4	-.887153E-01	.601153E-01	.257644E-01	-.271037E-01	-.209785E-01	-.107923	-.297288E-01
5	-.357135E-01	.242002E-01	.103718E-01	-.109109E-01	-.844515E-02	-.434458E-01	-.119677E-01
6	-.254374E-01	.172369E-01	.738743E-02	-.777147E-02	-.601517E-02	-.309448E-01	-.852415E-02

Ordered Probit Model: Cluster B (Ind 3, 11, and 14)

Maximum Likelihood Estimates	
Log-Likelihood.............	-296.46
Restricted (Slopes=0) Log-L.	-306.83
Chi-Squared (7)...........	20.742
Significance Level.........	.41720E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	10.	.05236	4	31.	.16230			
1	43.	.22513	5	7.	.03665			
2	46.	.24084						
3	54.	.28272						

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	2.4695	.4847	5.094	.00000		
X10	-.13874	.5817E-01	-2.385	.01706	2.6387	1.4763
X12	.11723	.4009E-01	2.924	.00345	2.5079	2.2568
X16	-.36280E-01	.7120E-01	-.510	.61036	4.5812	1.1754
X19	.27350E-02	.7182E-01	.038	.96962	2.4346	1.2751
X24	-.82159E-01	.5648E-01	-1.455	.14578	3.8010	1.4733
X38	-.76736E-01	.6987E-01	-1.098	.27211	4.7853	1.1612
X51	.30138E-01	.6094E-01	.495	.62094	4.4607	1.2679
MU(1)	1.0519	.1556	6.762	.00000		
MU(2)	1.7264	.1690	10.213	.00000		
MU(3)	2.5939	.1838	14.111	.00000		
MU(4)	3.6150	.2442	14.805	.00000		

Predicted Probablities:

	1
ROW 1	.452522E-01
ROW 2	.215557
ROW 3	.252632
ROW 4	.302813
ROW 5	.156460
ROW 6	.272852E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.132104E-01	-.111616E-01	.345436E-02	-.260412E-03	.782272E-02	.730638E-02	-.286954E-02
ROW 2	.318656E-01	-.269235E-01	.833245E-02	-.628155E-03	.188696E-01	.176241E-01	-.692177E-02
ROW 3	.102436E-01	-.865493E-02	.267858E-02	-.201929E-03	.606589E-02	.566551E-02	-.222510E-02
ROW 4	-.184412E-01	.155811E-01	-.482212E-02	.363523E-03	-.109202E-01	-.101994E-01	.400574E-02
ROW 5	-.281542E-01	.237877E-01	-.736196E-02	.554993E-03	-.166718E-01	-.155714E-01	.611558E-02
ROW 6	-.872435E-02	.737128E-02	-.228131E-02	.171980E-03	-.516623E-02	-.482523E-02	.189508E-02

Ordered Probit Model: Cluster C (Ind. 6, 13, 16, and 17)

Maximum Likelihood Estimates

Log-Likelihood..............	-204.28
Restricted (Slopes=0) Log-L.	-218.89
Chi-Squared (7)............	29.226
Significance Level..........	.13160E-03

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	10.	.07813	4	31.	.24219			
1	19.	.14844	5	12.	.09375			
2	31.	.24219						
3	25.	.19531						

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	3.6692	.5734	6.399	.00000		
X10	-.25091	.1142	-2.197	.02800	2.0469	1.2972
X12	.21420E-01	.3744E-01	.572	.56719	2.4531	2.3135
X16	-.14893E-01	.7290E-01	-.204	.83812	4.3750	1.3041
X19	-.17681	.1000	-1.767	.07718	2.0156	1.1432
X24	-.79253E-01	.7241E-01	-1.094	.27376	3.3125	1.5046
X38	-.26451	.7069E-01	-3.742	.00018	4.7578	1.2407
X51	.68266E-01	.7375E-01	.926	.35463	4.2109	1.3437
MU(1)	.66713	.1524	4.379	.00001		
MU(2)	1.4184	.1748	8.115	.00000		
MU(3)	2.0119	.1819	11.059	.00000		
MU(4)	3.0946	.2445	12.657	.00000		

Predicted Probablities:

	1
ROW 1	.602103E-01
ROW 2	.127630
ROW 3	.258636
ROW 4	.230375
ROW 5	.261567
ROW 6	.615817E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.299711E-01	-.255866E-02	.177895E-02	.211204E-01	.946679E-02	.315961E-01	-.815435E-02
ROW 2	.376392E-01	-.321329E-02	.223409E-02	.265241E-01	.118889E-01	.396800E-01	-.102406E-01
ROW 3	.315860E-01	-.269652E-02	.187480E-02	.222584E-01	.997688E-02	.332986E-01	-.859372E-02
ROW 4	-.910219E-02	.777063E-03	-.540265E-03	-.641426E-02	-.287506E-02	-.959572E-02	.247647E-02
ROW 5	-.595905E-01	.508730E-02	-.353702E-02	-.419931E-01	-.188225E-01	-.628215E-01	.162130E-01
ROW 6	-.305035E-01	.260411E-02	-.181055E-02	-.214956E-01	-.963497E-02	-.321574E-01	.829921E-02

Ordered Logit Model: Industry 4 - Machinery

Maximum Likelihood Estimates	
Log-Likelihood.............	-90.603
Restricted (Slopes=0) Log-L.	-92.770
Chi-Squared (6)...........	4.3337
Significance Level..........	.63162

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	3.	.04762	4	9.	.14286			
1	15.	.23810						
2	15.	.23810						
3	21.	.33333						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	3.2199	1.812	1.777	.07552		
X10	.12087	.1891	.639	.52258	2.6032	1.4651
X12	.23823	.1460	1.632	.10266	2.5397	1.8908
X16	-.13595	.2657	-.512	.60887	4.6508	.98634
X19	-.94838E-01	.2243	-.423	.67241	3.1905	1.2934
X24	.48783E-02	.1820	.027	.97861	4.0000	1.3678
X38	-.26691E-01	.2472	-.108	.91402	4.4444	1.1184
MU(1)	2.1464	.5871	3.656	.00026		
MU(2)	3.2216	.6228	5.173	.00000		
MU(3)	4.9837	.6983	7.137	.00000		

Predicted Probablities:

	1
ROW 1	.428761E-01
ROW 2	.234154
ROW 3	.251943
ROW 4	.338419
ROW 5	.132608

Matrix of partial effects:

	1	2	3	4	5	6
ROW 1	-.496042E-02	-.977639E-02	.557890E-02	.389195E-02	-.200193E-03	.109535E-02
ROW 2	-.192489E-01	-.379372E-01	.216489E-01	.151027E-01	-.776846E-03	.425052E-02
ROW 3	-.590788E-02	-.116437E-01	.664449E-02	.463532E-02	-.238430E-03	.130457E-02
ROW 4	.162138E-01	.319554E-01	-.182353E-01	-.127213E-01	.654355E-03	-.358031E-02
ROW 5	.139034E-01	.274019E-01	-.156369E-01	-.109086E-01	.561114E-03	-.307014E-02

Ordered Logit Model: Industry 5 - Electric Material and Communications

Maximum Likelihood Estimates

Log-Likelihood.............	-70.657
Restricted (Slopes=0) Log-L.	-77.357
Chi-Squared (6)............	13.400
Significance Level..........	.37104E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	6.	.10909	4	3.	.05455			
1	22.	.40000						
2	16.	.29091						
3	8.	.14545						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	5.7617	2.268	2.541	.01107		
X10	-.90128E-01	.1903	-.474	.63581	3.1273	1.4789
X12	.16095E-01	.2065	.078	.93787	1.7636	1.2614
X16	.86606E-01	.2214	.391	.69567	4.7273	1.1778
X19	-.56628	.2616	-2.164	.03043	3.7273	1.5087
X24	-.89727E-01	.2339	-.384	.70124	4.6364	1.2526
X38	-.20137	.2134	-.944	.34541	4.6545	1.2797
MU(1)	2.5046	.5095	4.916	.00000		
MU(2)	4.0768	.6334	6.437	.00000		
MU(3)	5.6459	.9659	5.845	.00000		

Predicted Probablities:

	1
ROW 1	.791682E-01
ROW 2	.433553
ROW 3	.322507
ROW 4	.125309
ROW 5	.394620E-01

Matrix of partial effects:

	1	2	3	4	5	6
ROW 1	.657039E-02	-.117330E-02	-.631362E-02	.412824E-01	.654115E-02	.146797E-01
ROW 2	.159470E-01	-.284774E-02	-.153238E-01	.100197	.158761E-01	.356293E-01
ROW 3	-.101139E-01	.180608E-02	.971859E-02	-.635463E-01	-.100688E-01	-.225966E-01
ROW 4	-.898731E-02	.160490E-02	.863608E-02	-.564681E-01	-.894731E-02	-.200797E-01
ROW 5	-.341628E-02	.610061E-03	.328277E-02	-.214648E-01	-.340108E-02	-.763274E-02

Ordered Logit Model: Industry 15 - Textiles

Maximum Likelihood Estimates	
Log-Likelihood.............	-72.820
Restricted (Slopes=0) Log-L.	-77.330
Chi-Squared (6)...........	9.0186
Significance Level..........	.17253

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	1.	.02041	4	7.	.14286			
1	14.	.28571	5	4.	.08163			
2	15.	.30612						
3	8.	.16327						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	5.6873	2.436	2.334	.01958		
X10	-.41220E-01	.3079	-.134	.89351	2.4694	1.2764
X12	.12187	.1327	.919	.35832	2.7347	2.3164
X16	-.15801	.2731	-.579	.56282	4.7143	1.1902
X19	-.40767	.3056	-1.334	.18225	2.2041	1.2073
X24	-.37450	.2466	-1.519	.12878	3.4286	1.3693
X38	.23276	.2843	.819	.41297	5.0408	.97808
MU(1)	3.2098	1.150	2.790	.00527		
MU(2)	4.6487	1.167	3.982	.00007		
MU(3)	5.5254	1.165	4.742	.00000		
MU(4)	6.8622	1.245	5.514	.00000		

Predicted Probablities:

	1
ROW 1	.152979E-01
ROW 2	.262625
ROW 3	.340776
ROW 4	.177186
ROW 5	.140997
ROW 6	.631169E-01

Matrix of partial effects:

	1	2	3	4	5	6
ROW 1	.620930E-03	-.183585E-02	.238029E-02	.614109E-02	.564143E-02	-.350619E-02
ROW 2	.765115E-02	-.226215E-01	.293302E-01	.756711E-01	.695142E-01	-.432035E-01
ROW 3	.145212E-02	-.429335E-02	.556659E-02	.143617E-01	.131932E-01	-.819963E-02
ROW 4	-.302796E-02	.895250E-02	-.116075E-01	-.299470E-01	-.275104E-01	.170979E-01
ROW 5	-.425878E-02	.125916E-01	-.163257E-01	-.421200E-01	-.386930E-01	.240479E-01
ROW 6	-.243746E-02	.720663E-02	-.934385E-02	-.241069E-01	-.221455E-01	.137635E-01

DIMENSION 2: DETERMINANTS OF A FIRM/INDUSTRY SHARE OF EXPORTS IN ITS TOTAL REVENUES

All Firms

Ordered Probit Model	
Maximum Likelihood Estimates	
Log-Likelihood...............	-699.01
Restricted (Slopes=0) Log-L.	-740.62
Chi-Squared (7)............	83.219
Significance Level..........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	294.	.51220	4	46.	.08014			
1	143.	.24913						
2	54.	.09408						
3	37.	.06446						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.0924	.7014	-2.983	.00285		
X55	-.22571	.1092	-2.068	.03867	3.5645	.72492
X14	.16749	.7198E-01	2.327	.01997	3.0174	1.2005
X29	.85908E-01	.6093E-01	1.410	.15855	4.1359	1.4359
X30	.28550	.6616E-01	4.315	.00002	4.5261	1.4260
X31	.18839	.5747E-01	3.278	.00105	4.2073	1.5599
X34	.17246	.7019E-01	2.457	.01401	5.0052	1.3722
X49	-.21454	.6741E-01	-3.183	.00146	4.5348	1.1910
MU(1)	1.2359	.9581E-01	12.900	.00000		
MU(2)	1.9064	.1239	15.390	.00000		
MU(3)	2.6083	.1650	15.806	.00000		

Predicted Probablities:

	1
ROW 1	.515274
ROW 2	.270051
ROW 3	.920142E-01
ROW 4	.578612E-01
ROW 5	.648001E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.563748E-01	-.418329E-01	-.214569E-01	-.713080E-01	-.470523E-01	-.430741E-01	.535845E-01
ROW 2	-.183224E-01	.135961E-01	.697373E-02	.231758E-01	.152925E-01	.139995E-01	-.174155E-01
ROW 3	-.137625E-01	.102125E-01	.523819E-02	.174081E-01	.114867E-01	.105155E-01	-.130814E-01
ROW 4	-.106116E-01	.787436E-02	.403892E-02	.134226E-01	.885683E-02	.810800E-02	-.100864E-01
ROW 5	-.136783E-01	.101499E-01	.520611E-02	.173015E-01	.114163E-01	.104511E-01	-.130012E-01

Ordered Logit Model: Cluster A (Ind. 1, 12, and 20)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood..............       -29.009
Restricted (Slopes=0) Log-L.       -35.964
Chi-Squared ( 7)............        13.910
Significance Level..........        .52801E-01
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	17.	.58621	4	3.	.10345			
1	4.	.13793						
2	3.	.10345						
3	2.	.06897						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-1.3348	6.486	-.206	.83695		
X55	.94116	1.494	.630	.52874	3.7931	.55929
X14	-.63248	.7927	-.798	.42493	2.8276	1.1361
X29	.83781	.6126	1.368	.17142	3.7931	1.3727
X30	-.40889	.6301	-.649	.51635	4.3103	1.6497
X31	.15876	.4405	.360	.71853	3.5862	1.5473
X34	.46454	.4577	1.015	.31015	4.2069	2.0420
X49	-1.0145	.5740	-1.768	.07713	4.6207	1.2653
MU(1)	.94994	.9209	1.032	.30228		
MU(2)	2.0321	1.071	1.897	.05787		
MU(3)	2.9275	1.278	2.291	.02198		

Predicted Probablities:

	1
ROW 1	.574953
ROW 2	.202698
ROW 3	.134018
ROW 4	.502628E-01
ROW 5	.380691E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.230002	.154566	-.204745	.999256E-01	-.387982E-01	-.113525	.247931
ROW 2	.672662E-01	-.452042E-01	.598795E-01	-.292242E-01	.113469E-01	.332013E-01	-.725098E-01
ROW 3	.869448E-01	-.584287E-01	.773972E-01	-.377737E-01	.146664E-01	.429143E-01	-.937225E-01
ROW 4	.413258E-01	-.277718E-01	.367877E-01	-.179542E-01	.697109E-02	.203976E-01	-.445473E-01
ROW 5	.344650E-01	-.231612E-01	.306803E-01	-.149735E-01	.581378E-02	.170113E-01	-.371517E-01

Ordered Logit Model: Cluster B (Ind. 3, 11, and 16)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood.............        -228.79
Restricted (Slopes=0) Log-L.       -243.41
Chi-Squared ( 7)............        29.240
Significance Level..........        .13082E-03
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	97.	.51596	4	18.	.09574			
1	45.	.23936						
2	15.	.07979						
3	13.	.06915						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.5974	1.220	-2.129	.03328		
X55	-.74599E-01	.2017	-.370	.71150	3.5479	.74061
X14	.25062	.1395	1.797	.07234	3.2500	1.1405
X29	.10704	.1214	.882	.37789	4.1755	1.3468
X30	.28149	.1201	2.343	.01913	4.4628	1.4194
X31	.21841	.1140	1.916	.05534	4.1436	1.4755
X34	.16981	.1523	1.115	.26486	5.1702	1.1759
X49	-.32428	.1441	-2.250	.02446	4.7287	1.0727
MU(1)	1.2076	.1671	7.225	.00000		
MU(2)	1.7479	.1990	8.785	.00000		
MU(3)	2.4075	.2668	9.025	.00000		

Predicted Probablities:

	1
ROW 1	.523704
ROW 2	.262552
ROW 3	.770222E-01
ROW 4	.610313E-01
ROW 5	.756901E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.186079E-01	-.625134E-01	-.266992E-01	-.702132E-01	-.544786E-01	-.423565E-01	.808876E-01
ROW 2	-.607094E-02	.203954E-01	.871079E-02	.229075E-01	.177740E-01	.138191E-01	-.263901E-01
ROW 3	-.373209E-02	.125380E-01	.535493E-02	.140823E-01	.109265E-01	.849524E-02	-.162232E-01
ROW 4	-.358579E-02	.120465E-01	.514502E-02	.135303E-01	.104982E-01	.816223E-02	-.155873E-01
ROW 5	-.521904E-02	.175334E-01	.748846E-02	.196930E-01	.152799E-01	.118799E-01	-.226869E-01

Ordered Logit Model: Cluster C (Ind. 4, 8, 9, and 15)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood..............          -181.26
Restricted (Slopes=0) Log-L.          -188.14
Chi-Squared ( 7)............           13.764
Significance Level..........           .55533E-01
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	57.	.41007	4	8.	.05755			
1	46.	.33094						
2	17.	.12230						
3	11.	.07914						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.9349	1.824	-1.609	.10762		
X55	.91878E-01	.2557	.359	.71938	3.6187	.66371
X14	.19955	.1655	1.206	.22792	3.0504	1.1185
X29	-.48204E-01	.1440	-.335	.73785	4.4029	1.3227
X30	.24148	.1455	1.660	.09690	4.8705	1.2559
X31	.25547	.1308	1.953	.05087	4.5108	1.4465
X34	.11487	.1470	.781	.43467	5.0647	1.2865
X49	-.68618E-01	.1429	-.480	.63103	4.5108	1.1940
MU(1)	1.5157	.2037	7.441	.00000		
MU(2)	2.3483	.2694	8.716	.00000		
MU(3)	3.3302	.3885	8.572	.00000		

Predicted Probablities:

	1
ROW 1	.402559
ROW 2	.351590
ROW 3	.121681
ROW 4	.737380E-01
ROW 5	.504318E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.220971E-01	-.479931E-01	.115932E-01	-.580784E-01	-.614408E-01	-.276268E-01	.165031E-01
ROW 2	.506220E-02	.109947E-01	-.265587E-02	.133051E-01	.140754E-01	.632900E-02	-.378067E-02
ROW 3	.704304E-02	.152969E-01	-.369512E-02	.185114E-01	.195831E-01	.880554E-02	-.526005E-02
ROW 4	.559199E-02	.121453E-01	-.293383E-02	.146976E-01	.155485E-01	.699137E-02	-.417634E-02
ROW 5	.439989E-02	.955619E-02	-.230839E-02	.115643E-01	.122338E-01	.550094E-02	-.328602E-02

Ordered Logit Model: Cluster D (Ind. 5, 7, 10, 13, 14, and 17)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood.............         -165.31
Restricted (Slopes=0) Log-L.        -183.75
Chi-Squared ( 7)............         36.867
Significance Level..........         .49707E-05
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	95.	.60127	4	16.	.10127			
1	30.	.18987						
2	11.	.06962						
3	6.	.03797						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.3960	1.511	-1.586	.11271		
X55	-.56794	.2021	-2.810	.00495	3.3924	.82813
X14	.14290	.1469	.973	.33062	2.8101	1.3024
X29	.92511E-01	.1121	.826	.40902	3.8987	1.6049
X30	.42840	.1574	2.722	.00648	4.3797	1.5126
X31	.24032	.1111	2.162	.03059	4.0886	1.7131
X34	.10675	.1750	.610	.54178	4.9177	1.4095
X49	-.79665E-01	.1365	-.584	.55935	4.3101	1.2664
MU(1)	1.0906	.1936	5.632	.00000		
MU(2)	1.6614	.2465	6.740	.00000		
MU(3)	2.0769	.3050	6.810	.00000		

Predicted Probablities:

	1
ROW 1	.627153
ROW 2	.206349
ROW 3	.650635E-01
ROW 4	.320952E-01
ROW 5	.693395E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.132803	-.334151E-01	-.216321E-01	-.100174	-.561940E-01	-.249616E-01	.186281E-01
ROW 2	-.539859E-01	.135837E-01	.879371E-02	.407218E-01	.228435E-01	.101472E-01	-.757256E-02
ROW 3	-.270515E-01	.680655E-02	.440639E-02	.204051E-01	.114465E-01	.508460E-02	-.379449E-02
ROW 4	-.151152E-01	.380322E-02	.246211E-02	.114015E-01	.639584E-02	.284106E-02	-.212020E-02
ROW 5	-.366501E-01	.922170E-02	.596989E-02	.276453E-01	.155081E-01	.688875E-02	-.514088E-02

Ordered Logit Model: Cluster E (Ind. 1, 7, and 20)

Ordered Probit Model	
Maximum Likelihood Estimates	
Log-Likelihood.............	-32.891
Restricted (Slopes=0) Log-L.	-42.063
Chi-Squared (7)............	18.345
Significance Level..........	.10506E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	14.	.46667	4	5.	.16667			
1	5.	.16667						
2	4.	.13333						
3	2.	.06667						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.7664	8.056	.219	.82644		
X55	1.0161	.8880	1.144	.25252	3.5000	.62972
X14	.48163	.7087	.680	.49674	2.7000	.95231
X29	-.13653	.6832	-.200	.84161	3.9333	1.5298
X30	.49253	.6926	.711	.47698	4.7667	1.2507
X31	-.36978	.4022	-.919	.35786	3.9000	1.5166
X34	-.13453	1.153	-.117	.90715	5.5667	.97143
X49	-1.3050	.7009	-1.862	.06261	4.4667	1.3830
MU(1)	1.0174	.4980	2.043	.04107		
MU(2)	2.1534	.8583	2.509	.01211		
MU(3)	2.9435	1.030	2.856	.00428		

Predicted Probablities:

	1
ROW 1	.397971
ROW 2	.248476
ROW 3	.204173
ROW 4	.755697E-01
ROW 5	.738106E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.243455	-.115395	.327113E-01	-.118004	.885946E-01	.322329E-01	.312668
ROW 2	.112146E-01	.531560E-02	-.150683E-02	.543582E-02	-.408107E-02	-.148479E-02	-.144029E-01
ROW 3	.103125	.488798E-01	-.138561E-01	.499853E-01	-.375276E-01	-.136535E-01	-.132442
ROW 4	.596502E-01	.282734E-01	-.801476E-02	.289129E-01	-.217070E-01	-.789754E-02	-.766084E-01
ROW 5	.694654E-01	.329257E-01	-.933356E-02	.336704E-01	-.252789E-01	-.919706E-02	-.892140E-01

Ordered Logit Model: Cluster F (Ind. 3, 11, and 14)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood.............      -219.80
Restricted (Slopes=0) Log-L.     -232.58
Chi-Squared ( 7)...........       25.551
Significance Level.........       .60562E-03
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	102.	.54545	4	15.	.08021			
1	44.	.23529						
2	14.	.07487						
3	12.	.06417						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.8254	1.236	-2.286	.02226		
X55	.21280E-01	.2016	.106	.91592	3.5561	.76257
X14	.27017	.1349	2.002	.04524	3.2299	1.1665
X29	.10641	.1206	.882	.37761	4.1551	1.3806
X30	.30578	.1177	2.599	.00935	4.4652	1.4303
X31	.16474	.1098	1.500	.13357	4.0749	1.5008
X34	.12718	.1503	.846	.39738	5.1604	1.1850
X49	-.30779	.1382	-2.227	.02595	4.8075	1.1000
MU(1)	1.2186	.1723	7.070	.00000		
MU(2)	1.7676	.2076	8.514	.00000		
MU(3)	2.4589	.2887	8.518	.00000		

Predicted Probablities:

	1
ROW 1	.555197
ROW 2	.253296
ROW 3	.711798E-01
ROW 4	.561996E-01
ROW 5	.641280E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.525523E-02	-.667198E-01	-.262780E-01	-.755134E-01	-.406828E-01	-.314067E-01	.760089E-01
ROW 2	.196036E-02	.248885E-01	.980250E-02	.281688E-01	.151759E-01	.117157E-01	-.283536E-01
ROW 3	.104238E-02	.132340E-01	.521228E-02	.149782E-01	.806949E-02	.622956E-02	-.150764E-01
ROW 4	.975344E-03	.123829E-01	.487707E-02	.140149E-01	.755052E-02	.582893E-02	-.141068E-01
ROW 5	.127715E-02	.162145E-01	.638619E-02	.183516E-01	.988690E-02	.763259E-02	-.184720E-01

Ordered Logit Model: Cluster G (Ind. 6, 13, 16, 17)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood.............        -138.35
Restricted (Slopes=0) Log-L.       -155.42
Chi-Squared ( 7)...........         34.139
Significance Level.........         .16220E-04
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	72.	.57143	4	13.	.10317			
1	24.	.19048						
2	8.	.06349						
3	9.	.07143						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.0094	1.439	-1.397	.16256		
X55	-.66907	.2372	-2.821	.00479	3.4048	.78157
X14	.26167	.1529	1.711	.08703	2.6905	1.2423
X29	.17821	.1408	1.266	.20546	4.1508	1.4370
X30	.18313	.1661	1.102	.27030	4.4365	1.5152
X31	.19554	.1236	1.581	.11377	4.0714	1.7444
X34	.37598	.2054	1.831	.06713	4.9683	1.4748
X49	-.23096	.1577	-1.465	.14298	4.3492	1.2021
MU(1)	1.0839	.2179	4.974	.00000		
MU(2)	1.5541	.2635	5.897	.00000		
MU(3)	2.2569	.3427	6.585	.00000		

Predicted Probablities:

	1
ROW 1	.591862
ROW 2	.218992
ROW 3	.619214E-01
ROW 4	.599049E-01
ROW 5	.673197E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.161622	-.632092E-01	-.430497E-01	-.442369E-01	-.472348E-01	-.908217E-01	.557914E-01
ROW 2	-.590066E-01	.230770E-01	.157170E-01	.161504E-01	.172449E-01	.331581E-01	-.203689E-01
ROW 3	-.283227E-01	.110768E-01	.754405E-02	.775209E-02	.827744E-02	.159156E-01	-.977690E-02
ROW 4	-.322833E-01	.126258E-01	.859899E-02	.883612E-02	.943493E-02	.181412E-01	-.111441E-01
ROW 5	-.420096E-01	.164296E-01	.111897E-01	.114983E-01	.122775E-01	.236068E-01	-.145016E-01

Ordered Logit Model: Industry 4 - Machinery

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood..............      -71.826
Restricted (Slopes=0) Log-L.      -78.033
Chi-Squared ( 7)............       12.413
Significance Level..........       .87762E-01
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	24.	.39344	4	2.	.03279			
1	24.	.39344						
2	6.	.09836						
3	5.	.08197						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-3.8055	3.712	-1.025	.30532		
X55	.79786	.6449	1.237	.21599	3.6885	.64655
X14	.42907	.3069	1.398	.16203	3.0492	1.0556
X29	-.13961	.2330	-.599	.54909	4.3607	1.3788
X30	.68583E-01	.2531	.271	.78643	4.8689	1.2176
X31	.28764	.2464	1.168	.24299	4.6721	1.4459
X34	.78790E-01	.2128	.370	.71125	4.7869	1.3798
X49	-.32132	.2350	-1.368	.17144	4.3770	1.2133
MU(1)	1.9845	.3977	4.990	.00000		
MU(2)	2.7961	.5484	5.099	.00000		
MU(3)	4.2123	.9137	4.610	.00000		

Predicted Probablities:

	1
ROW 1	.380974
ROW 2	.436463
ROW 3	.923237E-01
ROW 4	.667377E-01
ROW 5	.235017E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.188161	-.101189	.329252E-01	-.161742E-01	-.678346E-01	-.185812E-01	.757779E-01
ROW 2	.690935E-01	.371569E-01	-.120903E-01	.593924E-02	.249092E-01	.682309E-02	-.278260E-01
ROW 3	.535662E-01	.288067E-01	-.937326E-02	.460452E-02	.193114E-01	.528975E-02	-.215727E-01
ROW 4	.471907E-01	.253781E-01	-.825765E-02	.405648E-02	.170129E-01	.466016E-02	-.190051E-01
ROW 5	.183103E-01	.984688E-02	-.320403E-02	.157394E-02	.660113E-02	.180817E-02	-.737411E-02

Ordered Logit Model: Industry 5 - Electric Material and Communications

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood.............	-42.254
Restricted (Slopes=0) Log-L.	-51.836
Chi-Squared (7)............	19.164
Significance Level..........	.76874E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	27.	.56250	4	1.	.02083			
1	14.	.29167						
2	5.	.10417						
3	1.	.02083						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-5.7918	4.091	-1.416	.15688		
X55	-.12691	.7664	-.166	.86846	3.6667	.78098
X14	-.12087E-01	.3482	-.035	.97231	3.4375	1.3512
X29	.38891	.2389	1.628	.10350	3.5625	1.7492
X30	.56184	.3984	1.410	.15844	4.3125	1.5040
X31	.66147	.5271	1.255	.20955	4.6667	1.4341
X34	-.10115	.4340	-.233	.81571	4.6250	1.5106
X49	-.18056	.3733	-.484	.62864	4.0208	1.2115
MU(1)	1.9587	.5497	3.563	.00037		
MU(2)	3.3845	1.335	2.535	.01123		
MU(3)	4.1319	2.561	1.614	.10661		

Predicted Probablities:

	1
ROW 1	.645043
ROW 2	.282933
ROW 3	.537133E-01
ROW 4	.955501E-02
ROW 5	.875583E-02

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.290587E-01	.276746E-02	-.890450E-01	-.128640	-.151451	.231603E-01	.413422E-01
ROW 2	-.205762E-01	-.195961E-02	.630518E-01	.910882E-01	.107241	-.163995E-01	-.292740E-01
ROW 3	-.620120E-02	-.590582E-03	.190024E-01	.274520E-01	.323200E-01	-.494246E-02	-.882253E-02
ROW 4	-.117985E-02	-.112365E-03	.361543E-02	.522305E-02	.614925E-02	-.940359E-03	-.167859E-02
ROW 5	-.110152E-02	-.104905E-03	.337539E-02	.487628E-02	.574098E-02	-.877926E-03	-.156714E-02

Ordered Logit Model: Industry 15 - Textiles

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood.............	-59.718
Restricted (Slopes=0) Log-L.	-61.975
Chi-Squared (7)...........	4.5138
Significance Level..........	.71905

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	20.	.44444	4	4.	.08889			
1	12.	.26667						
2	6.	.13333						
3	3.	.06667						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-3.8691	3.946	-.980	.32688		
X55	-.17005	.4055	-.419	.67497	3.5111	.75745
X14	.96893E-02	.3610	.027	.97859	3.1778	1.1137
X29	.18739	.3126	.599	.54891	4.5556	1.2713
X30	.50937	.3289	1.549	.12145	5.2000	1.0574
X31	.83462E-01	.2317	.360	.71874	4.1111	1.3688
X34	-.20391E-02	.2881	-.007	.99435	5.0222	1.3398
X49	.17984	.3182	.565	.57195	4.5556	1.1785
MU(1)	1.2560	.3394	3.701	.00022		
MU(2)	2.1126	.4377	4.826	.00000		
MU(3)	2.7483	.5824	4.719	.00000		

Predicted Probablities:

	1
ROW 1	.445436
ROW 2	.292817
ROW 3	.130902
ROW 4	.570099E-01
ROW 5	.738358E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.420060E-01	-.239348E-02	-.462892E-01	-.125827	-.206171E-01	.503711E-03	-.444235E-01
ROW 2	-.914642E-02	.521159E-03	.100791E-01	.273977E-01	.448919E-02	-.109678E-03	.967283E-02
ROW 3	-.135207E-01	.770402E-03	.148994E-01	.405006E-01	.663614E-02	-.162132E-03	.142989E-01
ROW 4	-.771020E-02	.439323E-03	.849640E-02	.230955E-01	.378427E-02	-.924561E-04	.815395E-02
ROW 5	-.116286E-01	.662594E-03	.128144E-01	.348331E-01	.570750E-02	-.139444E-03	.122979E-01

DIMENSION 3: DETERMINANTS OF FIRM/INDUSTRY'S MAIN SOURCES OF TECHNOLOGY

All Firms

Dependent Variable: Firm's Own Technology Developement (44)

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood..............	-897.69
Restricted (Slopes=0) Log-L.	-912.63
Chi-Squared (9)............	29.877
Significance Level..........	.46029E-03

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	11.	.01818	4	175.	.28926			
1	24.	.03967	5	154.	.25455			
2	66.	.10909						
3	175.	.28926						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.4915	.6701	2.226	.02602		
X55	.91302E-01	.1023	.892	.37217	3.5537	.74307
X12	.46437E-01	.3362E-01	1.381	.16719	2.4992	2.2045
X10	-.59806E-01	.6656E-01	-.899	.36890	2.4512	1.4281
X49	.26011E-01	.6054E-01	.430	.66744	4.5587	1.1857
X50	.26852	.6406E-01	4.191	.00003	4.2678	1.1222
X51	.11270	.5987E-01	1.882	.05978	4.4083	1.2302
X52	.28727E-01	.6350E-01	.452	.65097	3.1074	1.2153
X53	.53033E-01	.6466E-01	.820	.41208	3.3587	1.2990
X54	.75235E-01	.7033E-01	1.070	.28476	3.4099	1.4062
MU(1)	1.2073	.2579	4.682	.00000		
MU(2)	2.4097	.2961	8.138	.00000		
MU(3)	3.8850	.3096	12.549	.00000		
MU(4)	5.1824	.3179	16.304	.00000		

Predicted Probablities:

ROW	1	.167790E-01
ROW	2	.372156E-01
ROW	3	.105631
ROW	4	.294078
ROW	5	.298735
ROW	6	.247562

Matrix of partial effects:

		1	2	3	4	5	6	7
ROW	1	-.150625E-02	-.766095E-03	.986639E-03	-.429118E-03	-.442983E-02	-.185923E-02	-.473925E-03
ROW	2	-.315738E-02	-.160588E-02	.206818E-02	-.899511E-03	-.928575E-02	-.389729E-02	-.993435E-03
ROW	3	-.758408E-02	-.385735E-02	.496780E-02	-.216064E-02	-.223045E-01	-.936134E-02	-.238624E-02
ROW	4	-.103821E-01	-.528045E-02	.680059E-02	-.295777E-02	-.305334E-01	-.128151E-01	-.326661E-02
ROW	5	.562253E-02	.285968E-02	-.368293E-02	.160181E-02	.165357E-01	.694012E-02	.176907E-02
ROW	6	.170073E-01	.865009E-02	-.111403E-01	.484523E-02	.500178E-01	.209928E-01	.535115E-02

8	9
-.874907E-03	-.124119E-02
-.183397E-02	-.260177E-02
-.440522E-02	-.624948E-02
-.603045E-02	-.855513E-02
.326585E-02	.463312E-02
.987869E-02	.140145E-01

All Firms (cont.)

Dependent Variable: Suppliers/Buyers' Technology Development (45)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood..............        -946.46
Restricted (Slopes=0) Log-L.        -966.38
Chi-Squared ( 9)............         39.830
Significance Level..........         .81571E-05
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	29.	.04841	4	155.	.25876			
1	46.	.07679	5	68.	.11352			
2	107.	.17863						
3	194.	.32387						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.9060	.6099	3.125	.00178		
X55	-.22338	.1016	-2.199	.02785	3.5509	.74308
X12	.48430E-01	.3472E-01	1.395	.16307	2.4992	2.2005
X10	-.17096	.6799E-01	-2.514	.01193	2.4341	1.4149
X49	.20812E-01	.6212E-01	.335	.73761	4.5559	1.1935
X50	.96360E-01	.6495E-01	1.484	.13793	4.2721	1.1204
X51	.18699	.6328E-01	2.955	.00313	4.3940	1.2329
X52	.70146E-01	.6246E-01	1.123	.26143	3.0985	1.2125
X53	.13689	.6315E-01	2.168	.03019	3.3439	1.2965
X54	.73295E-01	.7192E-01	1.019	.30812	3.4007	1.4034
MU(1)	1.0436	.1580	6.607	.00000		
MU(2)	2.1782	.1855	11.745	.00000		
MU(3)	3.5967	.2016	17.844	.00000		
MU(4)	5.2064	.2324	22.405	.00000		

Predicted Probablities:

	1
ROW 1	.443547E-01
ROW 2	.720916E-01
ROW 3	.174267
ROW 4	.337965
ROW 5	.265700
ROW 6	.105622

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.946845E-02	-.205282E-02	.724637E-02	-.882177E-03	-.408445E-02	-.792610E-02	-.297332E-02
ROW 2	.135143E-01	-.292997E-02	.103427E-01	-.125913E-02	-.582972E-02	-.113129E-01	-.424380E-02
ROW 3	.230778E-01	-.500341E-02	.176619E-01	-.215017E-02	-.995520E-02	-.193186E-01	-.724698E-02
ROW 4	.608557E-02	-.131939E-02	.465739E-02	-.566994E-03	-.262516E-02	-.509427E-02	-.191101E-02
ROW 5	-.310443E-01	.673059E-02	-.237587E-01	.289240E-02	.133917E-01	.259874E-01	.974864E-02
ROW 6	-.211018E-01	.457500E-02	-.161496E-01	.196606E-02	.910280E-02	.176645E-01	.662647E-02

	8	9
ROW 1	-.580240E-02	-.310678E-02
ROW 2	-.828173E-02	-.443429E-02
ROW 3	-.141424E-01	-.757228E-02
ROW 4	-.372932E-02	-.199679E-02
ROW 5	.190244E-01	.101862E-01
ROW 6	.129315E-01	.692391E-02

All Firms (cont.)

Dependent Variable: University/Research Institutes' Technology Developement(46)

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood..............	-1028.5
Restricted (Slopes=0) Log-L.	-1039.0
Chi-Squared (9)............	21.039
Significance Level..........	.12478E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	71.	.11833	4	84.	.14000			
1	95.	.15833	5	57.	.09500			
2	145.	.24167						
3	148.	.24667						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	2.6957	.5948	4.532	.00001		
X55	-.11703	.9742E-01	-1.201	.22964	3.5517	.74493
X12	.16417E-01	.3508E-01	.468	.63976	2.4833	2.1896
X10	.17857E-01	.6060E-01	.295	.76823	2.4450	1.4202
X49	-.17922	.5993E-01	-2.991	.00278	4.5583	1.1842
X50	.84312E-01	.6314E-01	1.335	.18177	4.2700	1.1192
X51	.17512E-01	.5873E-01	.298	.76554	4.4033	1.2247
X52	.13826	.6315E-01	2.189	.02857	3.1133	1.2205
X53	.27668E-01	.5995E-01	.461	.64445	3.3600	1.2922
X54	-.13457	.6442E-01	-2.089	.03671	3.4083	1.3970
MU(1)	1.0692	.1059	10.100	.00000		
MU(2)	2.1275	.1278	16.648	.00000		
MU(3)	3.2561	.1476	22.059	.00000		
MU(4)	4.3451	.1830	23.745	.00000		

Predicted Probablities:

	1
ROW 1	.114109
ROW 2	.158742
ROW 3	.246651
ROW 4	.250199
ROW 5	.138814
ROW 6	.914846E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.118299E-01	-.165960E-02	-.180512E-02	.181169E-01	-.852294E-02	-.177030E-02	-.139763E-01
ROW 2	.113884E-01	-.159767E-02	-.173775E-02	.174407E-01	-.820485E-02	-.170423E-02	-.134547E-01
ROW 3	.599363E-02	-.840840E-03	-.914568E-03	.917893E-02	-.431815E-02	-.896923E-03	-.708110E-02
ROW 4	-.846778E-02	.118794E-02	.129210E-02	-.129680E-01	.610068E-02	.126717E-02	.100042E-01
ROW 5	-.110175E-01	.154564E-02	.168116E-02	-.168728E-01	.793765E-02	.164873E-02	.130165E-01
ROW 6	-.972661E-02	.136454E-02	.148418E-02	-.148958E-01	.700761E-02	.145555E-02	.114914E-01

	8	9
	-.279686E-02	.136039E-01
	-.269248E-02	.130962E-01
	-.141703E-02	.689242E-02
	.200198E-02	-.973759E-02
	.260480E-02	-.126697E-01
	.229960E-02	-.111852E-01

All Firms (cont.)

Dependent Variable: Engineering Firms' Technology Development (47)

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood..............	-1003.6
Restricted (Slopes=0) Log-L.	-1011.4
Chi-Squared (9)............	15.572
Significance Level..........	.76381E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	91.	.15268	4	83.	.13926			
1	104.	.17450	5	28.	.04698			
2	152.	.25503						
3	138.	.23154						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	2.8625	.6104	4.689	.00000		
X55	-.20908	.9969E-01	-2.097	.03597	3.5554	.74380
X12	.44058E-01	.3488E-01	1.263	.20652	2.4883	2.1951
X10	-.53978E-01	.6349E-01	-.850	.39521	2.4547	1.4200
X49	-.10819	.5927E-01	-1.825	.06796	4.5638	1.1772
X50	.67873E-02	.6431E-01	.106	.91595	4.2718	1.1167
X51	-.19099E-01	.5875E-01	-.325	.74514	4.4027	1.2281
X52	.65910E-01	.6304E-01	1.045	.29580	3.1158	1.2210
X53	.60704E-01	.6282E-01	.966	.33385	3.3641	1.2938
X54	-.63375E-01	.6736E-01	-.941	.34680	3.4128	1.3990
MU(1)	1.0091	.9436E-01	10.694	.00000		
MU(2)	2.0821	.1175	17.715	.00000		
MU(3)	3.2399	.1426	22.727	.00000		
MU(4)	4.7880	.2205	21.716	.00000		

Predicted Probablities:

	1
ROW 1	.149212
ROW 2	.175607
ROW 3	.259697
ROW 4	.232921
ROW 5	.137224
ROW 6	.453388E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.265418E-01	-.559309E-02	.685234E-02	.137341E-01	-.861633E-03	.242454E-02	-.836714E-02
ROW 2	.193111E-01	-.406937E-02	.498557E-02	.999256E-02	-.626900E-03	.176403E-02	-.608770E-02
ROW 3	.492278E-02	-.103736E-02	.127092E-02	.254730E-02	-.159809E-03	.449686E-03	-.155188E-02
ROW 4	-.195744E-01	.412487E-02	-.505356E-02	-.101288E-01	.635449E-03	-.178808E-02	.617072E-02
ROW 5	-.221518E-01	.466798E-02	-.571896E-02	-.114625E-01	.719118E-03	-.202352E-02	.698321E-02
ROW 6	-.904948E-02	.190697E-02	-.233632E-02	-.468268E-02	.293776E-03	-.826653E-03	.285280E-02

	8	9
ROW 1	-.770622E-02	.804526E-02
ROW 2	-.560683E-02	.585351E-02
ROW 3	-.142929E-02	.149218E-02
ROW 4	.568329E-02	-.593333E-02
ROW 5	.643160E-02	-.671457E-02
ROW 6	.262745E-02	-.274305E-02

All Firms (cont.)

Dependent Variable: Foreign Technology (48)

```
Ordered Probit Model
Maximum Likelihood Estimates
Log-Likelihood.............     -919.26
Restricted (Slopes=0) Log-L.    -943.95
Chi-Squared ( 9)...........      49.390
Significance Level.........      .13955E-06
```

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	24.	.03987	4	196.	.32558			
1	34.	.05648	5	166.	.27575			
2	63.	.10465						
3	119.	.19767						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	.65518	.6188	1.059	.28971		
X55	.14639	.1025	1.428	.15318	3.5631	.73887
X12	.35116E-01	.3544E-01	.991	.32169	2.4950	2.1961
X10	-.12696	.6556E-01	-1.936	.05281	2.4585	1.4209
X49	.79858E-01	.6313E-01	1.265	.20587	4.5482	1.1900
X50	.70868E-01	.6452E-01	1.098	.27206	4.2691	1.1248
X51	.17028E-01	.6115E-01	.278	.78067	4.3904	1.2408
X52	.32517	.6302E-01	5.160	.00000	3.1096	1.2229
X53	-.66241E-01	.6255E-01	-1.059	.28959	3.3538	1.2974
X54	.23951	.6941E-01	3.451	.00056	3.4103	1.4034
MU(1)	.96686	.1727	5.598	.00000		
MU(2)	1.8568	.2036	9.121	.00000		
MU(3)	2.8742	.2189	13.133	.00000		
MU(4)	4.3294	.2346	18.453	.00000		

Predicted Probablities:

	1
ROW 1	.356196E-01
ROW 2	.529090E-01
ROW 3	.102735
ROW 4	.204208
ROW 5	.341609
ROW 6	.262920

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.502855E-02	-.120628E-02	.436110E-02	-.274320E-02	-.243439E-02	-.584924E-03	-.111699E-01
ROW 2	-.678369E-02	-.162731E-02	.588328E-02	-.370067E-02	-.328407E-02	-.789082E-03	-.150686E-01
ROW 3	-.108313E-01	-.259828E-02	.939366E-02	-.590876E-02	-.524358E-02	-.125990E-02	-.240595E-01
ROW 4	-.123540E-01	-.296355E-02	.107142E-01	-.673941E-02	-.598073E-02	-.143702E-02	-.274418E-01
ROW 5	.662859E-02	.159011E-02	-.574877E-02	.361606E-02	.320899E-02	.771041E-03	.147240E-01
ROW 6	.283689E-01	.680532E-02	-.246035E-01	.154760E-01	.137338E-01	.329989E-02	.630157E-01

	8	9
	.227543E-02	-.822737E-02
	.306963E-02	-.110990E-01
	.490119E-02	-.177215E-01
	.559020E-02	-.202128E-01
	-.299945E-02	.108452E-01
	-.128370E-01	.464154E-01

Ordered Logit Model: Cluster A (Ind. 10, 15, and 17)

Dependent Variable: Firm's Own Technology Developement (44)

Significance Level.......... .18599E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	3.	.02459	4	29.	.23770			
1	9.	.07377	5	31.	.25410			
2	14.	.11475						
3	36.	.29508						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-.96467E-01	1.304	-.074	.94104		
X55	.18508	.2179	.849	.39576	3.3361	.81930
X12	.63303E-01	.7278E-01	.870	.38443	2.7049	2.5703
X10	-.20728	.2220	-.934	.35055	2.0492	1.1982
X49	.38922E-01	.1527	.255	.79881	4.2951	1.1970
X50	.53270	.1810	2.943	.00325	4.1803	1.0603
X51	.13917	.1412	.986	.32422	4.3115	1.3611
X52	.77534E-01	.1386	.559	.57590	3.0082	1.3391
X53	-.70644E-01	.1548	-.456	.64821	3.1311	1.2659
X54	.24069	.2169	1.110	.26713	2.7459	1.3272

Dependent Variable: Suppliers/Buyers' Technology Development (45)

Significance Level.......... .75737E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	4.	.03279	4	40.	.32787			
1	10.	.08197	5	17.	.13934			
2	18.	.14754						
3	33.	.27049						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.3954	1.240	1.125	.26048		
X55	-.10424E-01	.2299	-.045	.96384	3.3361	.81930
X12	.28274E-01	.7203E-01	.393	.69465	2.7049	2.5703
X10	-.21181	.2216	-.956	.33910	2.0492	1.1982
X49	-.82887E-01	.1679	-.494	.62150	4.2951	1.1970
X50	.17982	.1959	.918	.35865	4.1803	1.0603
X51	.43552	.1478	2.946	.00322	4.3115	1.3611
X52	.21563E-01	.1401	.154	.87771	3.0082	1.3391
X53	.17747E-01	.1627	.109	.91316	3.1311	1.2659
X54	.62805E-01	.2207	.285	.77599	2.7459	1.3272

Ordered Logit Model: Cluster A (Ind. 10, 15, and 17) (cont.)

Dependent Variable: University/Research Institutes' Technology Developement(46)

Significance Level.......... .14439

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	7.	.05785	4	24.	.19835			
1	18.	.14876	5	17.	.14050			
2	26.	.21488						
3	29.	.23967						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	2.4615	1.286	1.914	.05556		
X55	.56128E-01	.2078	.270	.78710	3.3306	.82045
X12	-.42262E-01	.6775E-01	-.624	.53278	2.7107	2.5802
X10	.14548	.2041	.713	.47597	2.0413	1.2000
X49	-.32382	.1633	-1.983	.04739	4.2893	1.2003
X50	.29446	.1717	1.715	.08633	4.1736	1.0621
X51	.23181	.1504	1.541	.12330	4.3058	1.3653
X52	-.19326	.1505	-1.284	.19907	3.0083	1.3447
X53	.12559	.1556	.807	.41972	3.1405	1.2669
X54	-.18924	.2008	-.942	.34607	2.7355	1.3277

Dependent Variable: Engineering Firms' Technology Development (47)

Significance Level.......... .74323

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	10.	.08333	4	25.	.20833			
1	22.	.18333	5	5.	.04167			
2	26.	.21667						
3	32.	.26667						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	3.6676	1.268	2.892	.00383		
X55	-.13075	.2140	-.611	.54115	3.3333	.82333
X12	-.11781	.7224E-01	-1.631	.10292	2.7250	2.5862
X10	-.35008E-01	.1872	-.187	.85162	2.0500	1.2012
X49	-.60269E-01	.1638	-.368	.71298	4.2750	1.1950
X50	.84834E-01	.1910	.444	.65689	4.1750	1.0664
X51	.47304E-01	.1419	.333	.73883	4.3000	1.3695
X52	-.52190E-01	.1588	-.329	.74249	3.0083	1.3504
X53	-.51120E-01	.1550	-.330	.74150	3.1500	1.2679
X54	-.13114	.1923	-.682	.49525	2.7417	1.3316

Ordered Logit Model: Cluster A (Ind. 10, 15, and 17) (cont.)

Dependent Variable: Foreign Technology (48)

Significance Level.......... .10060E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	10.	.08333	4	37.	.30833			
1	9.	.07500	5	29.	.24167			
2	11.	.09167						
3	24.	.20000						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-1.7625	1.378	-1.279	.20103		
X55	.33979	.2309	1.472	.14115	3.3500	.81633
X12	.61516E-01	.7403E-01	.831	.40601	2.7333	2.5822
X10	.12967E-02	.2183	.006	.99526	2.0667	1.2004
X49	.24995E-01	.1578	.158	.87416	4.2750	1.1950
X50	.22481	.1848	1.217	.22371	4.1917	1.0635
X51	.10675	.1369	.780	.43542	4.3000	1.3695
X52	.47304	.1521	3.110	.00187	3.0000	1.3473
X53	-.12130	.1609	-.754	.45094	3.1333	1.2698
X54	.22580	.2227	1.014	.31055	2.7500	1.3363

Ordered Logit Model: Cluster B (Ind. 1, 2, 4-9, 11, 12, and 14)

Dependent Variable: Firm's Own Technology Developement (44)

Significance Level.......... .38255E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	4.	.01143	4	102.	.29143			
1	13.	.03714	5	92.	.26286			
2	36.	.10286						
3	103.	.29429						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.9698	1.073	1.836	.06642		
X55	.64071E-01	.1451	.441	.65890	3.6143	.72398
X12	.76590E-01	.5509E-01	1.390	.16446	2.2800	1.8716
X10	-.74918E-01	.8319E-01	-.901	.36781	2.6486	1.5195
X49	.51164E-01	.8170E-01	.626	.53117	4.5886	1.2097
X50	.26578	.8676E-01	3.063	.00219	4.3371	1.1231
X51	.73492E-01	.8046E-01	.913	.36102	4.3971	1.2298
X52	-.15370E-01	.8799E-01	-.175	.86133	3.1829	1.1997
X53	.53570E-01	.8925E-01	.600	.54835	3.4571	1.3252
X54	.14257	.9632E-01	1.480	.13882	3.6714	1.3847

Dependent Variable: Suppliers/Buyers' Technology Development (45)

Significance Level.......... .48333E-03

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	18.	.05187	4	79.	.22767			
1	24.	.06916	5	44.	.12680			
2	65.	.18732						
3	117.	.33718						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.5190	.9048	1.679	.09319		
X55	-.26707	.1450	-1.841	.06556	3.6081	.72267
X12	.89060E-01	.5631E-01	1.582	.11375	2.2853	1.8768
X10	-.20317	.8099E-01	-2.509	.01212	2.6254	1.5104
X49	.10319	.7951E-01	1.298	.19439	4.5879	1.2213
X50	.15106	.8383E-01	1.802	.07155	4.3343	1.1241
X51	.11186	.8462E-01	1.322	.18621	4.3804	1.2351
X52	.16217E-01	.8726E-01	.186	.85256	3.1816	1.2016
X53	.20335	.8180E-01	2.486	.01292	3.4496	1.3320
X54	.11618	.9161E-01	1.268	.20472	3.6628	1.3848

Ordered Logit Model: Cluster B (Ind. 1, 2, 4-9, 11, 12, and 14) (cont.)

Dependent Variable: University/Research Institutes' Technology Developement(46)

Significance Level.......... .60938

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	47.	.13467	4	46.	.13181			
1	54.	.15473	5	32.	.09169			
2	81.	.23209						
3	89.	.25501						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob¦t¦≥x	Mean of X	Std.Dev.of X
Constant	1.7861	.8397	2.127	.03341		
X55	.34951E-01	.1479	.236	.81316	3.6132	.72473
X12	.48356E-01	.5575E-01	.867	.38578	2.2579	1.8498
X10	-.18722E-02	.7367E-01	-.025	.97972	2.6418	1.5164
X49	-.90974E-01	.7886E-01	-1.154	.24865	4.5931	1.2037
X50	.11171	.8672E-01	1.288	.19772	4.3381	1.1246
X51	-.36359E-01	.7678E-01	-.474	.63583	4.3954	1.2217
X52	.11521	.8897E-01	1.295	.19535	3.1948	1.2043
X53	-.46660E-01	.7891E-01	-.591	.55433	3.4585	1.3225
X54	-.68560E-01	.8495E-01	-.807	.41963	3.6676	1.3766

Dependent Variable: Engineering Firms' Technology Development (47)

Significance Level.......... .52651

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	63.	.18156	4	45.	.12968			
1	60.	.17291	5	18.	.05187			
2	84.	.24207						
3	77.	.22190						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob¦t¦≥x	Mean of X	Std.Dev.of X
Constant	1.8104	.8668	2.089	.03675		
X55	-.15230	.1357	-1.122	.26186	3.6167	.72132
X12	.10986	.5264E-01	2.087	.03688	2.2565	1.8547
X10	-.55225E-01	.7781E-01	-.710	.47785	2.6513	1.5156
X49	-.23115E-01	.7643E-01	-.302	.76231	4.6052	1.1911
X50	.13589E-01	.8782E-01	.155	.87703	4.3343	1.1241
X51	-.53706E-01	.7510E-01	-.715	.47451	4.3977	1.2225
X52	.60649E-01	.8590E-01	.706	.48018	3.2046	1.2003
X53	.22916E-01	.8246E-01	.278	.78108	3.4697	1.3173
X54	.46434E-01	.8803E-01	.527	.59785	3.6686	1.3800

Ordered Logit Model: Cluster B (Ind. 1, 2, 4-9, 11, 12, and 14) (cont.)

Dependent Variable: Foreign Technology (48)

Significance Level.......... .14360E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	8.	.02273	4	122.	.34659			
1	16.	.04545	5	115.	.32670			
2	27.	.07670						
3	64.	.18182						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob¦t¦≥x	Mean of X	Std.Dev.of X
Constant	1.5250	.9076	1.680	.09292		
X55	.12362	.1371	.902	.36712	3.6222	.71760
X12	.99539E-02	.5337E-01	.187	.85205	2.2727	1.8673
X10	-.17548	.7905E-01	-2.220	.02642	2.6534	1.5170
X49	.49688E-01	.8295E-01	.599	.54917	4.5795	1.2146
X50	.46511E-01	.8592E-01	.541	.58827	4.3295	1.1345
X51	.73344E-01	.7884E-01	.930	.35225	4.3778	1.2458
X52	.16320	.8466E-01	1.928	.05389	3.1932	1.2064
X53	.81651E-01	.8253E-01	.989	.32252	3.4545	1.3240
X54	.20794	.9107E-01	2.283	.02241	3.6648	1.3841

Ordered Logit Model: Cluster C (Ind. 16, and 18)

Dependent Variable: Firm's Own Technology Developement (44)

Significance Level.......... .31985E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	1.	.03846	4	6.	.23077			
1	1.	.03846	5	5.	.19231			
2	3.	.11538						
3	10.	.38462						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-10.458	8.367	-1.250	.21131		
X55	1.3479	1.171	1.151	.24976	3.3846	.69725
X12	.10992	.4209	.261	.79399	2.4615	2.4204
X10	.31042	.4595	.676	.49932	2.1923	1.1321
X49	1.0406	1.004	1.037	.29974	4.6923	1.0495
X50	.56584	.8585	.659	.50981	3.7692	1.1422
X51	.34702	.7340	.473	.63638	4.2692	.96157
X52	.83094	.6411	1.296	.19491	3.6154	1.2354
X53	.57653	.8989	.641	.52127	3.8846	1.3661
X54	-.93292	.5354	-1.742	.08144	3.3077	1.2576

Dependent Variable: Suppliers/Buyers' Technology Development (45)

Significance Level.......... .12328

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	1.	.04000	4	8.	.32000			
1	1.	.04000						
2	7.	.28000						
3	8.	.32000						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-3.1595	7.852	-.402	.68741		
X55	-.52465	1.231	-.426	.66985	3.4000	.70711
X12	.16795	.3774	.445	.65634	2.5200	2.4515
X10	.86265	.9157	.942	.34617	2.2000	1.1547
X49	-.16839	.6873	-.245	.80645	4.6400	1.0360
X50	.43344	1.188	.365	.71517	3.7600	1.1648
X51	1.1487	1.508	.762	.44631	4.2800	.97980
X52	1.0706	1.118	.958	.33813	3.5200	1.1590
X53	-1.0909	1.029	-1.060	.28902	3.8000	1.3229
X54	.45950	.9795	.469	.63900	3.2800	1.2754

Ordered Logit Model: Cluster C (Ind. 16, and 18) (cont.)

Dependent Variable: University/Research Institutes' Technology Developement(46)

Significance Level.......... .13901E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	4.	.15385	4	5.	.19231			
1	4.	.15385	5	2.	.07692			
2	4.	.15385						
3	7.	.26923						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-1.1018	4.857	-.227	.82055		
X55	-2.8438	1.050	-2.708	.00676	3.3846	.69725
X12	.21406	.3453	.620	.53532	2.4615	2.4204
X10	.52506	1.080	.486	.62673	2.1923	1.1321
X49	.46910	.9763	.480	.63090	4.6923	1.0495
X50	-.38559	.7756	-.497	.61908	3.7692	1.1422
X51	1.8371	.9997	1.838	.06612	4.2692	.96157
X52	.20520	.7467	.275	.78347	3.6154	1.2354
X53	.45425E-01	.9423	.048	.96155	3.8846	1.3661
X54	.86334	.5842	1.478	.13946	3.3077	1.2576

Dependent Variable: Engineering Firms' Technology Development (47)

Significance Level.......... .16606

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	6.	.24000	4	3.	.12000			
1	6.	.24000	5	1.	.04000			
2	5.	.20000						
3	4.	.16000						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-1.0591	8.015	-.132	.89488		
X55	-.94722	1.555	-.609	.54233	3.3600	.70000
X12	.15522	.3032	.512	.60865	2.5200	2.4515
X10	-.37046	.6086	-.609	.54269	2.2400	1.1284
X49	-.47102E-01	.7251	-.065	.94821	4.7200	1.0614
X50	.42840	.5675	.755	.45028	3.8400	1.1060
X51	.40631	.9124	.445	.65610	4.2800	.97980
X52	.51010	.4013	1.271	.20369	3.6000	1.2583
X53	.28333	.7448	.380	.70364	3.8800	1.3940
X54	.80942E-01	.5158	.157	.87530	3.4000	1.1902

Ordered Logit Model: Cluster C (Ind. 16, and 18) (cont.)

Dependent Variable: Foreign Technology (48)

Significance Level.......... .27576

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	1.	.03846	4	5.	.19231			
1	3.	.11538	5	4.	.15385			
2	7.	.26923						
3	6.	.23077						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob¦t¦≥x	Mean of X	Std.Dev.of X
Constant	-1.5254	4.937	-.309	.75733		
X55	.11743	.6936	.169	.86556	3.3846	.69725
X12	-.14351	.3244	-.442	.65822	2.4615	2.4204
X10	-.62520	.5241	-1.193	.23295	2.1923	1.1321
X49	.88268	.7146	1.235	.21675	4.6923	1.0495
X50	.34197	.5772	.592	.55355	3.7692	1.1422
X51	.12570	.8079	.156	.87635	4.2692	.96157
X52	.20266	.7892	.257	.79735	3.6154	1.2354
X53	-.58423E-02	.5342	-.011	.99127	3.8846	1.3661
X54	.10802E-01	.3991	.027	.97840	3.3077	1.2576

Ordered Logit Model: Industry 3 - Metal Products

Dependent Variable: Firm's Own Technology Developement (44)

Significance Level.......... .56378

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	2.	.02151	4	35.	.37634			
1	1.	.01075	5	24.	.25806			
2	10.	.10753						
3	21.	.22581						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	5.6755	2.296	2.472	.01342		
X55	.15592	.3798	.411	.68143	3.6774	.62834
X12	-.12855	.8797E-01	-1.461	.14395	3.2043	2.6888
X10	-.87399E-01	.2040	-.428	.66839	2.3441	1.3063
X49	-.32906	.1820	-1.808	.07064	4.7097	1.1091
X50	-.62925E-01	.1776	-.354	.72311	4.2796	1.2102
X51	.49380E-02	.1922	.026	.97951	4.6237	1.1695
X52	-.17807	.2004	-.889	.37413	2.8172	1.0728
X53	.16463	.1802	.914	.36081	3.1183	1.1873
X54	.36192E-01	.2260	.160	.87277	3.3441	1.3792

Suppliers/Buyers' Technology Development (45)

Significance Level.......... .34292

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	4.	.04396	4	26.	.28571			
1	11.	.12088	5	7.	.07692			
2	15.	.16484						
3	28.	.30769						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	4.1642	1.997	2.086	.03700		
X55	-.42303	.3148	-1.344	.17903	3.6813	.63033
X12	.83724E-03	.8588E-01	.010	.99222	3.1758	2.6608
X10	-.20548	.2163	-.950	.34213	2.3187	1.2550
X49	.11925E-01	.1695	.070	.94392	4.7143	1.1184
X50	-.23770	.1749	-1.359	.17419	4.3187	1.1914
X51	.11916	.1847	.645	.51880	4.5934	1.1641
X52	.29655	.1870	1.586	.11272	2.7912	1.0700
X53	-.23189E-01	.1993	-.116	.90739	3.0769	1.1569
X54	.23488	.2114	1.111	.26650	3.3297	1.3586

Ordered Logit Model: Industry 3 - Metal Products (cont.)

Dependent Variable: University/Research Institutes' Technology Developement(46)

Significance Level.......... .12181E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	11.	.12222	4	9.	.10000			
1	17.	.18889	5	5.	.05556			
2	28.	.31111						
3	20.	.22222						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	5.7278	2.364	2.423	.01539		
X55	-.77918	.3263	-2.388	.01693	3.6778	.63295
X12	.30423E-01	.9197E-01	.331	.74080	3.2000	2.6656
X10	-.30390	.2205	-1.378	.16805	2.3333	1.2542
X49	-.12584	.1998	-.630	.52886	4.7000	1.1163
X50	-.15870	.2007	-.791	.42914	4.3000	1.1846
X51	-.10228	.1795	-.570	.56877	4.6111	1.1582
X52	.50612	.2007	2.521	.01169	2.8000	1.0726
X53	.25231E-01	.1883	.134	.89339	3.1000	1.1421
X54	.71766E-01	.2190	.328	.74318	3.3556	1.3434

Dependent Variable: Engineering Firms' Technology Development (47)

Significance Level.......... .70983E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	10.	.11111	4	10.	.11111			
1	13.	.14444	5	3.	.03333			
2	30.	.33333						
3	24.	.26667						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	5.2305	2.469	2.118	.03417		
X55	-.73058	.4317	-1.692	.09058	3.6889	.62969
X12	.12068	.8377E-01	1.441	.14969	3.2000	2.6656
X10	-.27972	.2207	-1.267	.20499	2.3333	1.2542
X49	-.14018	.1850	-.758	.44864	4.7000	1.1163
X50	-.59398E-01	.1846	-.322	.74759	4.3000	1.1846
X51	-.19493E-01	.1942	-.100	.92005	4.6000	1.1689
X52	.19660	.1829	1.075	.28246	2.7889	1.0757
X53	.32830	.1952	1.681	.09268	3.0778	1.1634
X54	-.16273	.2313	-.704	.48170	3.3444	1.3588

Ordered Logit Model: Industry 3 - Metal Products (cont.)

Dependent Variable: Foreign Technology (48)

Significance Level.......... .44552E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	5.	.05556	4	29.	.32222			
1	5.	.05556	5	14.	.15556			
2	17.	.18889						
3	20.	.22222						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	2.6045	2.108	1.236	.21653		
X55	.18884E-01	.4143	.046	.96364	3.6889	.62969
X12	.13716	.8410E-01	1.631	.10292	3.2000	2.6656
X10	-.32363	.2170	-1.492	.13578	2.3333	1.2542
X49	.20217	.2233	.905	.36526	4.7000	1.1163
X50	-.30505	.1956	-1.560	.11883	4.3000	1.1846
X51	-.25564	.1769	-1.445	.14835	4.6000	1.1689
X52	.66797	.2284	2.925	.00345	2.7889	1.0757
X53	-.34764	.1994	-1.743	.08125	3.0778	1.1634
X54	.48810	.2109	2.314	.02066	3.3444	1.3588

DIMENSION 4: DETERMINANTS OF DISTINCT ADJUSTMENT OPTIONS WITH LIBERALIZATION POLICY WITHIN FIRMS AND INDUSTRIES

All Firms

Dependent Variable: Substitution of own production for imported products (19)

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood..............	-841.07
Restricted (Slopes=0) Log-L.	-896.98
Chi-Squared (9)............	111.81
Significance Level..........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	188.	.32639	4	30.	.05208			
1	142.	.24653	5	16.	.02778			
2	129.	.22396						
3	71.	.12326						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.4699	.5401	-4.573	.00000		
X12	-.44677E-01	.3576E-01	-1.249	.21159	2.4948	2.1948
X9	.16180	.6948E-01	2.329	.01987	3.5955	1.1638
X10	.29110	.5693E-01	5.114	.00000	2.4375	1.4104
X29	.66825E-01	.5302E-01	1.260	.20756	4.1076	1.4490
X40	.14308	.6843E-01	2.091	.03654	4.4253	1.1918
X44	-.75280E-01	.6519E-01	-1.155	.24819	4.5399	1.1979
X47	-.19015	.5597E-01	-3.397	.00068	3.1667	1.3981
X48	.27048	.6468E-01	4.181	.00003	4.5503	1.3439
X53	.28652	.6078E-01	4.714	.00000	3.3524	1.2985
MU(1)	1.1551	.8706E-01	13.268	.00000		
MU(2)	2.3815	.1249	19.067	.00000		
MU(3)	3.5766	.1853	19.304	.00000		
MU(4)	4.7754	.3020	15.815	.00000		

Predicted Probablities:

	1
ROW 1	.296301
ROW 2	.275717
ROW 3	.248003
ROW 4	.117685
ROW 5	.426544E-01
ROW 6	.196391E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.931537E-02	-.337368E-01	-.606972E-01	-.139334E-01	-.298323E-01	.156964E-01	.396482E-01
ROW 2	.162207E-02	-.587453E-02	-.105691E-01	-.242619E-02	-.519464E-02	.273319E-02	.690388E-02
ROW 3	-.434377E-02	.157315E-01	.283032E-01	.649716E-02	.139108E-01	-.731926E-02	-.184880E-01
ROW 4	-.398397E-02	.144284E-01	.259588E-01	.595898E-02	.127586E-01	-.671299E-02	-.169566E-01
ROW 5	-.174952E-02	.633611E-02	.113995E-01	.261683E-02	.560280E-02	-.294794E-02	-.744634E-02
ROW 6	-.860179E-03	.311525E-02	.560476E-02	.128660E-02	.275470E-02	-.144940E-02	-.366111E-02

	8	9
ROW 1	-.563963E-01	-.597423E-01
ROW 2	-.982019E-02	-.104028E-01
ROW 3	.262977E-01	.278579E-01
ROW 4	.241194E-01	.255504E-01
ROW 5	.105918E-01	.112202E-01
ROW 6	.520762E-02	.551659E-02

All Firms (cont.)

Dependent Variable: Rationalization of production lines (16)

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood.............	-824.51
Restricted (Slopes=0) Log-L.	-866.36
Chi-Squared (9)............	83.700
Significance Level..........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	20.	.03431	4	216.	.37050			
1	21.	.03602	5	125.	.21441			
2	46.	.07890						
3	155.	.26587						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob¦t¦≥x	Mean of X	Std.Dev.of X
Constant	-1.2197	.5174	-2.357	.01841		
X12	.31377E-01	.3301E-01	.951	.34185	2.4889	2.1894
X9	.23233	.6708E-01	3.463	.00053	3.5986	1.1592
X10	.24161E-02	.6039E-01	.040	.96809	2.4305	1.4050
X29	.15818	.5459E-01	2.898	.00376	4.1132	1.4434
X40	.21914	.6560E-01	3.340	.00084	4.4271	1.1875
X44	.33287	.6200E-01	5.369	.00000	4.5489	1.1959
X47	.55925E-02	.5348E-01	.105	.91672	3.1664	1.3989
X48	.91446E-01	.5487E-01	1.666	.09562	4.5472	1.3460
X53	.10369	.5889E-01	1.761	.07830	3.3602	1.3005
MU(1)	.80765	.1768	4.567	.00000		
MU(2)	1.7211	.2169	7.934	.00000		
MU(3)	3.2529	.2401	13.549	.00000		
MU(4)	5.0530	.2594	19.480	.00000		

Predicted Probablities:

	1
ROW 1	.261545E-01
ROW 2	.306543E-01
ROW 3	.737372E-01
ROW 4	.279358
ROW 5	.397887
ROW 6	.192209

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.799182E-03	-.591768E-02	-.615390E-04	-.402879E-02	-.558154E-02	-.847829E-02	-.142443E-03
ROW 2	-.882038E-03	-.653120E-02	-.679191E-04	-.444648E-02	-.616021E-02	-.935729E-02	-.157211E-03
ROW 3	-.188017E-02	-.139220E-01	-.144777E-03	-.947820E-02	-.131312E-01	-.199461E-01	-.335113E-03
ROW 4	-.402812E-02	-.298269E-01	-.310175E-03	-.203063E-01	-.281326E-01	-.427332E-01	-.717956E-03
ROW 5	.271780E-02	.201244E-01	.209277E-03	.137008E-01	.189813E-01	.288323E-01	.484409E-03
ROW 6	.487171E-02	.360734E-01	.375134E-03	.245590E-01	.340243E-01	.516826E-01	.868314E-03

8	9
-.232916E-02	-.264092E-02
-.257064E-02	-.291472E-02
-.547962E-02	-.621306E-02
-.117397E-01	-.133110E-01
.792083E-02	.898103E-02
.141983E-01	.160987E-01

All Firms (cont.)

Dependent Variable: Purchase of foreign technology/Products licensing (24)

Ordered Probit Model	
Maximum Likelihood Estimates	
Log-Likelihood..............	-902.13
Restricted (Slopes=0) Log-L.	-972.61
Chi-Squared (9)............	140.96
Significance Level..........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	74.	.12825	4	149.	.25823			
1	48.	.08319	5	55.	.09532			
2	86.	.14905						
3	165.	.28596						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.7318	.5214	-5.239	.00000		
X12	.10488E-01	.3652E-01	.287	.77398	2.4922	2.1843
X9	.39812E-01	.6790E-01	.586	.55764	3.5979	1.1642
X10	.47149E-01	.5835E-01	.808	.41908	2.4402	1.4082
X29	.17521	.5074E-01	3.453	.00055	4.1109	1.4475
X40	.19772	.6441E-01	3.070	.00214	4.4281	1.1912
X44	.31560E-01	.6195E-01	.509	.61045	4.5459	1.1997
X47	-.24988E-01	.5446E-01	-.459	.64635	3.1716	1.3994
X48	.50826	.5909E-01	8.602	.00000	4.5529	1.3467
X53	.21650	.5630E-01	3.846	.00012	3.3553	1.3005
MU(1)	.70983	.9950E-01	7.134	.00000		
MU(2)	1.5989	.1279	12.505	.00000		
MU(3)	2.9857	.1532	19.487	.00000		
MU(4)	4.8162	.2021	23.827	.00000		

Predicted Probablities:

	1
ROW 1	.950817E-01
ROW 2	.809780E-01
ROW 3	.165990
ROW 4	.333335
ROW 5	.253066
ROW 6	.715497E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	-.902365E-03	-.342548E-02	-.405679E-02	-.150755E-01	-.170125E-01	-.271548E-02	.215002E-02
ROW 2	-.618994E-03	-.234977E-02	-.278283E-02	-.103413E-01	-.116700E-01	-.186273E-02	.147484E-02
ROW 3	-.838892E-03	-.318453E-02	-.377143E-02	-.140151E-01	-.158158E-01	-.252447E-02	.199878E-02
ROW 4	.609463E-04	.231359E-03	.273998E-03	.101821E-02	.114903E-02	.183405E-03	-.145214E-03
ROW 5	.160261E-02	.608370E-02	.720489E-02	.267743E-01	.302143E-01	.482272E-02	-.381846E-02
ROW 6	.696695E-03	.264473E-02	.313215E-02	.116394E-01	.131349E-01	.209656E-02	-.165998E-02

	8	9
	-.437314E-01	-.186278E-01
	-.299983E-01	-.127781E-01
	-.406553E-01	-.173175E-01
	.295365E-02	.125813E-02
	.776674E-01	.330831E-01
	.337640E-01	.143821E-01

All Firms (cont.)

Dependent Variable: Association with multinational enterprises (21)

Ordered Probit Model
Maximum Likelihood Estimates

Log-Likelihood.............	-928.78
Restricted (Slopes=0) Log-L.	-961.03
Chi-Squared (9)...........	64.492
Significance Level..........	.10000E-06

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	157.	.27352	4	79.	.13763			
1	91.	.15854	5	19.	.03310			
2	111.	.19338						
3	117.	.20383						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.0285	.5136	-3.949	.00008		
X12	-.91712E-02	.3384E-01	-.271	.78641	2.5174	2.2127
X9	-.81872E-01	.6628E-01	-1.235	.21677	3.5923	1.1642
X10	.14681	.5565E-01	2.638	.00833	2.4216	1.4006
X29	.81746E-01	.5117E-01	1.598	.11013	4.1063	1.4463
X40	.15459	.6763E-01	2.286	.02226	4.4268	1.1907
X44	.10290E-01	.6337E-01	.162	.87100	4.5523	1.1977
X47	.63156E-01	.5483E-01	1.152	.24936	3.1725	1.3955
X48	.24227	.5883E-01	4.118	.00004	4.5453	1.3500
X53	.20541	.5759E-01	3.567	.00036	3.3641	1.2990
MU(1)	.76493	.7504E-01	10.194	.00000		
MU(2)	1.6225	.9998E-01	16.229	.00000		
MU(3)	2.7617	.1341	20.596	.00000		
MU(4)	4.6086	.2495	18.475	.00000		

Predicted Probablities:

	1
ROW 1	.255534
ROW 2	.168952
ROW 3	.210387
ROW 4	.209661
ROW 5	.127252
ROW 6	.282148E-01

Matrix of partial effects:

	1	2	3	4	5	6	7
ROW 1	.174470E-02	.155751E-01	-.279292E-01	-.155511E-01	-.294091E-01	-.195758E-02	-.120146E-01
ROW 2	.495809E-03	.442612E-02	-.793693E-02	-.441931E-02	-.835748E-02	-.556305E-03	-.341431E-02
ROW 3	-.114532E-03	-.102243E-02	.183343E-02	.102086E-02	.193057E-02	.128506E-03	.788706E-03
ROW 4	-.921824E-03	-.822918E-02	.147566E-01	.821652E-02	.155385E-01	.103430E-02	.634799E-02
ROW 5	-.952691E-03	-.850473E-02	.152507E-01	.849165E-02	.160588E-01	.106893E-02	.656056E-02
ROW 6	-.251464E-03	-.224483E-02	.402544E-02	.224138E-02	.423873E-02	.282146E-03	.173167E-02

	8	9
ROW 1	-.460893E-01	-.390761E-01
ROW 2	-.130977E-01	-.111047E-01
ROW 3	.302556E-02	.256517E-02
ROW 4	.243516E-01	.206461E-01
ROW 5	.251670E-01	.213375E-01
ROW 6	.664286E-02	.563205E-02

Ordered Logit Model: Cluster A (Ind. 3-6, 8-14, and 18)

Depenpent Variable: Substitution of own production for imported products (19)

Maximum Likelihood Estimates	
Log-Likelihood.............	-599.28
Restricted (Slopes=0) Log-L.	-639.09
Chi-Squared (9)............	79.626
Significance Level..........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	98.	.24936	4	27.	.06870			
1	97.	.24682	5	15.	.03817			
2	100.	.25445						
3	56.	.14249						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-1.6592	.6932	-2.394	.01668		
X12	-.12300E-01	.4609E-01	-.267	.78956	2.4300	2.0827
X9	.13467	.8550E-01	1.575	.11524	3.6794	1.1357
X10	.24115	.6381E-01	3.779	.00016	2.6081	1.4774
X29	.18868E-01	.6342E-01	.298	.76607	4.1018	1.4498
X40	.22558	.8011E-01	2.816	.00487	4.4148	1.2094
X44	-.19510	.8126E-01	-2.401	.01635	4.6132	1.1487
X47	-.20808	.6661E-01	-3.124	.00178	3.1425	1.3997
X48	.24338	.8146E-01	2.988	.00281	4.6845	1.2422
X53	.34694	.7142E-01	4.858	.00000	3.4326	1.2980
MU(1)	1.2082	.1110	10.889	.00000		
MU(2)	2.4935	.1535	16.244	.00000		
MU(3)	3.6631	.2170	16.880	.00000		
MU(4)	4.8906	.3330	14.689	.00000		

Predicted Probablities:

	1
ROW 1	.216587
ROW 2	.264054
ROW 3	.289283
ROW 4	.145166
ROW 5	.584401E-01
ROW 6	.264700E-01

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	.208710E-02	-.228511E-01	-.409173E-01	-.320144E-02	-.382757E-01	.331045E-01	.353066E-01
ROW 2	.983396E-03	-.107669E-01	-.192793E-01	-.150845E-02	-.180347E-01	.155981E-01	.166357E-01
ROW 3	-.891587E-03	.976174E-02	.174794E-01	.136762E-02	.163510E-01	-.141419E-01	-.150826E-01
ROW 4	-.122316E-02	.133921E-01	.239799E-01	.187623E-02	.224318E-01	-.194012E-01	-.206917E-01
ROW 5	-.638774E-03	.699377E-02	.125230E-01	.979827E-03	.117146E-01	-.101319E-01	-.108059E-01
ROW 6	-.316975E-03	.347047E-02	.621423E-02	.486213E-03	.581305E-02	-.502769E-02	-.536213E-02

	8	9
ROW 1	-.412959E-01	-.588685E-01
ROW 2	-.194577E-01	-.277375E-01
ROW 3	.176411E-01	.251480E-01
ROW 4	.242018E-01	.345004E-01
ROW 5	.126389E-01	.180172E-01
ROW 6	.627173E-02	.894054E-02

Ordered Logit Model: Cluster A (Ind. 3-6, 8-14, and 18) (cont.)

Dependent Variable: Rationalization of production lines (16)

Maximum Likelihood Estimates	
Log-Likelihood.............	-545.82
Restricted (Slopes=0) Log-L.	-569.24
Chi-Squared (9)............	46.836
Significance Level..........	.42027E-06

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	11.	.02764	4	157.	.39447			
1	13.	.03266	5	84.	.21106			
2	24.	.06030						
3	109.	.27387						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-.64807	.7226	-.897	.36982		
X12	.38119E-01	.4233E-01	.900	.36787	2.4221	2.0785
X9	.23193	.8667E-01	2.676	.00745	3.6809	1.1317
X10	-.24613E-01	.7031E-01	-.350	.72628	2.5980	1.4733
X29	.16278	.6584E-01	2.472	.01342	4.1106	1.4452
X40	.23242	.7842E-01	2.964	.00304	4.4171	1.2053
X44	.33851	.8093E-01	4.183	.00003	4.6206	1.1464
X47	.44382E-01	.6533E-01	.679	.49694	3.1407	1.4000
X48	-.17561E-01	.7399E-01	-.237	.81239	4.6759	1.2509
X53	.67866E-01	.7251E-01	.936	.34933	3.4322	1.2949
MU(1)	.85041	.2438	3.488	.00049		
MU(2)	1.6473	.2954	5.576	.00000		
MU(3)	3.3130	.3286	10.082	.00000		
MU(4)	5.2070	.3511	14.829	.00000		

Predicted Probablities:

	1
ROW 1	.222237E-01
ROW 2	.282882E-01
ROW 3	.550552E-01
ROW 4	.278786
ROW 5	.421435
ROW 6	.194213

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.828312E-03	-.503987E-02	.534842E-03	-.353724E-02	-.505046E-02	-.735583E-02	-.964409E-03
ROW 2	-.999876E-03	-.608375E-02	.645620E-03	-.426989E-02	-.609654E-02	-.887941E-02	-.116416E-02
ROW 3	-.177108E-02	-.107761E-01	.114359E-02	-.756326E-02	-.107988E-01	-.157281E-01	-.206208E-02
ROW 4	-.542059E-02	-.329816E-01	.350008E-02	-.231482E-01	-.330509E-01	-.481376E-01	-.631123E-02
ROW 5	.305451E-02	.185852E-01	-.197230E-02	.130441E-01	.186243E-01	.271256E-01	.355639E-02
ROW 6	.596535E-02	.362962E-01	-.385183E-02	.254746E-01	.363725E-01	.529753E-01	.694549E-02

	8	9
ROW 1	.381606E-03	-.147471E-02
ROW 2	.460646E-03	-.178016E-02
ROW 3	.815942E-03	-.315320E-02
ROW 4	.249728E-02	-.965072E-02
ROW 5	-.140722E-02	.543819E-02
ROW 6	-.274825E-02	.106206E-01

Ordered Logit Model: Cluster A (Ind. 3-6, 8-14, and 18) (cont.)

Dependent Variable: Purchase of foreign technology/Products licensing (24)

Maximum Likelihood Estimates	
Log-Likelihood.............	-600.05
Restricted (Slopes=0) Log-L.	-644.33
Chi-Squared (9)...........	88.559
Significance Level.........	.00000

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	39.	.09924	4	113.	.28753			
1	22.	.05598	5	49.	.12468			
2	53.	.13486						
3	117.	.29771						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.3205	.6805	-3.410	.00065		
X12	.10107E-01	.4754E-01	.213	.83163	2.4224	2.0677
X9	-.95102E-02	.8630E-01	-.110	.91225	3.6845	1.1371
X10	-.84136E-03	.6806E-01	-.012	.99014	2.6132	1.4753
X29	.22270	.5974E-01	3.728	.00019	4.1094	1.4483
X40	.21216	.7504E-01	2.827	.00470	4.4198	1.2098
X44	-.27705E-01	.7712E-01	-.359	.71942	4.6209	1.1523
X47	.14189E-01	.6712E-01	.211	.83258	3.1450	1.4004
X48	.51802	.7484E-01	6.921	.00000	4.6845	1.2463
X53	.19046	.6705E-01	2.841	.00450	3.4402	1.3004
MU(1)	.60006	.1269	4.727	.00000		
MU(2)	1.5276	.1718	8.891	.00000		
MU(3)	2.9720	.2027	14.663	.00000		
MU(4)	4.7603	.2506	18.995	.00000		

Predicted Probablities:

	1
ROW 1	.745988E-01
ROW 2	.534813E-01
ROW 3	.142735
ROW 4	.340759
ROW 5	.292398
ROW 6	.960284E-01

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.697707E-03	.656527E-03	.580826E-04	-.153738E-01	-.146460E-01	.191257E-02	-.979551E-03
ROW 2	-.430969E-03	.405532E-03	.358772E-04	-.949629E-02	-.904674E-02	.118138E-02	-.605062E-03
ROW 3	-.867144E-03	.815964E-03	.721879E-04	-.191073E-01	-.182028E-01	.237703E-02	-.121743E-02
ROW 4	-.405048E-03	.381141E-03	.337194E-04	-.892514E-02	-.850262E-02	.111032E-02	-.568670E-03
ROW 5	.152353E-02	-.143361E-02	-.126831E-03	.335707E-01	.319815E-01	-.417633E-02	.213898E-02
ROW 6	.877335E-03	-.825553E-03	-.730363E-04	.193319E-01	.184167E-01	-.240496E-02	.123174E-02

	8	9
ROW 1	-.357607E-01	-.131481E-01
ROW 2	-.220891E-01	-.812150E-02
ROW 3	-.444452E-01	-.163411E-01
ROW 4	-.207606E-01	-.763302E-02
ROW 5	.780881E-01	.287106E-01
ROW 6	.449675E-01	.165332E-01

Ordered Logit Model: Cluster A (Ind. 3-6, 8-14, and 18) (cont.)

Dependent Variable: Association with multinational enterprises (21)

Maximum Likelihood Estimates

Log-Likelihood.............	-639.27
Restricted (Slopes=0) Log-L.	-663.10
Chi-Squared (9)...........	47.651
Significance Level..........	.29597E-06

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	92.	.23529	4	61.	.15601			
1	56.	.14322	5	16.	.04092			
2	76.	.19437						
3	90.	.23018						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-1.9402	.6960	-2.788	.00531		
X12	.24138E-02	.4554E-01	.053	.95773	2.4399	2.0917
X9	-.53745E-01	.8439E-01	-.637	.52419	3.6803	1.1335
X10	.10533	.6285E-01	1.676	.09375	2.6010	1.4709
X29	.12863	.6090E-01	2.112	.03467	4.1049	1.4489
X40	.20806	.8099E-01	2.569	.01020	4.4194	1.2081
X44	-.78811E-01	.7926E-01	-.994	.32004	4.6240	1.1522
X47	.50562E-01	.6661E-01	.759	.44781	3.1535	1.3985
X48	.26319	.7567E-01	3.478	.00050	4.6803	1.2538
X53	.19524	.6918E-01	2.822	.00477	3.4450	1.2995
MU(1)	.74161	.9395E-01	7.894	.00000		
MU(2)	1.6068	.1251	12.846	.00000		
MU(3)	2.8082	.1638	17.147	.00000		
MU(4)	4.6204	.2816	16.410	.00000		

Predicted Probablities:

	1
ROW 1	.216049
ROW 2	.150459
ROW 3	.212313
ROW 4	.241630
ROW 5	.145044
ROW 6	.345050E-01

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.408832E-03	.910287E-02	-.178406E-01	-.217859E-01	-.352392E-01	.133483E-01	-.856379E-02
ROW 2	-.151607E-03	.337561E-02	-.661584E-02	-.807887E-02	-.130677E-01	.494995E-02	-.317571E-02
ROW 3	-.280180E-04	.623837E-03	-.122265E-02	-.149303E-02	-.241501E-02	.914785E-03	-.586893E-03
ROW 4	.232875E-03	-.518509E-02	.101622E-01	.124095E-01	.200726E-01	-.760333E-02	.487802E-02
ROW 5	.275167E-03	-.612675E-02	.120078E-01	.146632E-01	.237180E-01	-.898418E-02	.576392E-02
ROW 6	.804147E-04	-.179048E-02	.350915E-02	.428516E-02	.693133E-02	-.262553E-02	.168445E-02

	8	9
ROW 1	-.445776E-01	-.330684E-01
ROW 2	-.165307E-01	-.122627E-01
ROW 3	-.305499E-02	-.226624E-02
ROW 4	.253919E-01	.188361E-01
ROW 5	.300033E-01	.222569E-01
ROW 6	.876815E-02	.650435E-02

Ordered Logit Model: Cluster B (Ind. 15 and 16)

Dependent Variable: Substitution of own production for imported products (19)

Maximum Likelihood Estimates	
Log-Likelihood.............	-74.260
Restricted (Slopes=0) Log-L.	-83.355
Chi-Squared (9)............	18.190
Significance Level..........	.33035E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	27.	.41538						
1	18.	.27692						
2	13.	.20000						
3	7.	.10769						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	.24694	1.779	.139	.88958		
X12	-.18160	.1347	-1.349	.17748	2.7846	2.4334
X9	.26488	.2795	.948	.34333	3.8769	1.0534
X10	.54985	.2639	2.083	.03722	2.3385	1.1219
X29	-.12253	.2321	-.528	.59749	4.4308	1.2496
X40	-.29419	.2501	-1.176	.23951	4.6769	1.0474
X44	.30150E-02	.2017	.015	.98807	4.2615	1.2781
X47	.54054	.2373	2.278	.02272	3.1846	1.4130
X48	-.24629	.2591	-.951	.34176	4.4615	1.4151
X53	-.99958E-01	.2409	-.415	.67822	3.3692	1.1933
MU(1)	1.4252	.3206	4.445	.00001		
MU(2)	2.9893	.5465	5.470	.00000		

Predicted Probablities:[a]

	1
ROW 1	.393212
ROW 2	.336139
ROW 3	.198590
ROW 4	.720592E-01

a. No firm in the sample reported the dependent variable with values 5 and 6, what made impossible estimations for these levels.

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	.433288E-01	-.631996E-01	-.131192	.292356E-01	.701921E-01	-.719369E-03	-.128970
ROW 2	-.748152E-02	.109126E-01	.226528E-01	-.504808E-02	-.121200E-01	.124212E-03	.222691E-01
ROW 3	-.237043E-01	.345753E-01	.717727E-01	-.159942E-01	-.384007E-01	.393553E-03	.705570E-01
ROW 4	-.121429E-01	.177117E-01	.367666E-01	-.819329E-02	-.196713E-01	.201603E-03	.361439E-01

	8	9
ROW 1	.587629E-01	.238496E-01
ROW 2	-.101465E-01	-.411808E-02
ROW 3	-.321480E-01	-.130477E-01
ROW 4	-.164683E-01	-.668386E-02

Ordered Logit Model: Cluster B (Ind. 15 and 16) (cont.)

Dependent Variable: Rationalization of production lines (16)

Maximum Likelihood Estimates	
Log-Likelihood..............	-86.117
Restricted (Slopes=0) Log-L.	-93.875
Chi-Squared (9)............	15.517
Significance Level..........	.77687E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	1.	.01515	4	24.	.36364			
1	1.	.01515	5	20.	.30303			
2	8.	.12121						
3	12.	.18182						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-.92727	2.898	-.320	.74903		
X12	-.11379E-01	.1094	-.104	.91713	2.7576	2.4246
X9	-.41063E-01	.2684	-.153	.87842	3.8788	1.0454
X10	-.19812	.2737	-.724	.46918	2.3333	1.1140
X29	.14422	.2293	.629	.52940	4.4242	1.2411
X40	.41896	.2408	1.740	.08186	4.6818	1.0401
X44	.46509	.2218	2.097	.03597	4.2879	1.2862
X47	.39310E-02	.2063	.019	.98480	3.2121	1.4198
X48	.22037	.2110	1.044	.29626	4.4697	1.4057
X53	.18542	.2704	.686	.49294	3.4091	1.2276
MU(1)	.72146	1.177	.613	.53989		
MU(2)	2.6160	1.370	1.909	.05627		
MU(3)	3.8046	1.376	2.765	.00570		
MU(4)	5.6304	1.377	4.089	.00004		

Predicted Probablities:

	1
ROW 1	.953375E-02
ROW 2	.988556E-02
ROW 3	.969433E-01
ROW 4	.185446
ROW 5	.426697
ROW 6	.271495

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	.107455E-03	.387749E-03	.187084E-02	-.136189E-02	-.395618E-02	-.439177E-02	-.371194E-04
ROW 2	.109236E-03	.394174E-03	.190184E-02	-.138446E-02	-.402174E-02	-.446454E-02	-.377345E-04
ROW 3	.953376E-03	.344023E-02	.165987E-01	-.120832E-01	-.351005E-01	-.389652E-01	-.329336E-03
ROW 4	.122782E-02	.443057E-02	.213770E-01	-.155615E-01	-.452048E-01	-.501820E-01	-.424141E-03
ROW 5	-.147190E-03	-.531133E-03	-.256265E-02	.186550E-02	.541912E-02	.601578E-02	.508456E-04
ROW 6	-.225070E-02	-.812159E-02	-.391857E-01	.285256E-01	.828641E-01	.919878E-01	.777485E-03

	8	9
	-.208094E-02	-.175085E-02
	-.211543E-02	-.177987E-02
	-.184628E-01	-.155341E-01
	-.237777E-01	-.200059E-01
	.285044E-02	.239829E-02
	.435864E-01	.366725E-01

Ordered Logit Model: Cluster B (Ind. 15 and 16) (cont.)

Dependent Variable: Purchase of foreign technology/Products licensing (24)

Maximum Likelihood Estimates	
Log-Likelihood.............	-98.209
Restricted (Slopes=0) Log-L.	-103.01
Chi-Squared (9)............	9.6076
Significance Level..........	.38318

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	5.	.07692	4	11.	.16923			
1	9.	.13846	5	2.	.03077			
2	15.	.23077						
3	23.	.35385						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	.35802	2.305	.155	.87657		
X12	-.94295E-01	.1272	-.741	.45841	2.7846	2.4334
X9	.13543	.2439	.555	.57871	3.8769	1.0534
X10	.16776	.3042	.551	.58132	2.3385	1.1219
X29	.93843E-02	.2222	.042	.96632	4.4308	1.2496
X40	.70170E-01	.2908	.241	.80932	4.6769	1.0474
X44	-.14526	.2151	-.675	.49943	4.2615	1.2781
X47	.69841E-01	.2240	.312	.75520	3.1846	1.4130
X48	.62916E-01	.2237	.281	.77852	4.4615	1.4151
X53	.42619	.2682	1.589	.11201	3.3692	1.1933
MU(1)	1.3120	.5529	2.373	.01764		
MU(2)	2.5316	.7002	3.615	.00030		
MU(3)	4.3388	.7396	5.866	.00000		
MU(4)	6.4555	.9737	6.630	.00000		

Predicted Probablities:

	1
ROW 1	.628225E-01
ROW 2	.136502
ROW 3	.258039
ROW 4	.379659
ROW 5	.140066
ROW 6	.229121E-01

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	.555167E-02	-.797342E-02	-.987676E-02	-.552511E-03	-.413132E-02	.855253E-02	-.411195E-02
ROW 2	.949718E-02	-.136400E-01	-.168961E-01	-.945175E-03	-.706740E-02	.146307E-01	-.703426E-02
ROW 3	.835337E-02	-.119973E-01	-.148611E-01	-.831340E-03	-.621622E-02	.128686E-01	-.618707E-02
ROW 4	-.105389E-01	.151362E-01	.187493E-01	.104885E-02	.784260E-02	-.162355E-01	.780583E-02
ROW 5	-.107523E-01	.154427E-01	.191291E-01	.107009E-02	.800143E-02	-.165643E-01	.796392E-02
ROW 6	-.211099E-02	.303184E-02	.375558E-02	.210089E-03	.157091E-02	-.325205E-02	.156354E-02

8	9
-.370421E-02	-.250926E-01
-.633676E-02	-.429256E-01
-.557357E-02	-.377557E-01
.703181E-02	.476339E-01
.717423E-02	.485987E-01
.140850E-02	.954129E-02

Ordered Logit Model: Cluster B (Ind. 15 and 16) (cont.)

Dependent Variable: Association with multinational enterprises (21)

Maximum Likelihood Estimates	
Log-Likelihood..............	-82.797
Restricted (Slopes=0) Log-L.	-91.754
Chi-Squared (9)............	17.913
Significance Level..........	.36195E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	24.	.37500	4	4.	.06250			
1	18.	.28125						
2	12.	.18750						
3	6.	.09375						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	1.3255	1.771	.748	.45425		
X12	-.16682	.1299	-1.284	.19912	2.7969	2.4507
X9	.31747E-01	.2985	.106	.91529	3.8750	1.0616
X10	.50607	.2889	1.751	.07987	2.2969	1.0791
X29	-.25147	.2483	-1.013	.31113	4.4375	1.2583
X40	-.75120E-01	.2492	-.301	.76310	4.6875	1.0522
X44	-.20665	.2217	-.932	.35133	4.2813	1.2783
X47	.63597	.2620	2.427	.01523	3.1563	1.4054
X48	-.29575	.2373	-1.246	.21267	4.4688	1.4250
X53	.38016E-01	.2386	.159	.87343	3.3906	1.1901
MU(1)	1.4329	.3150	4.548	.00001		
MU(2)	2.6760	.4517	5.924	.00000		
MU(3)	3.7862	.6194	6.113	.00000		

Predicted Probablities:[a]

	1
ROW 1	.352946
ROW 2	.342726
ROW 3	.192267
ROW 4	.721378E-01
ROW 5	.399240E-01

a. No firm in the sample reported the dependent variable with value 6, what made impossible estimations for this level.

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	.380964E-01	-.725032E-02	-.115573	.574302E-01	.171556E-01	.471930E-01	-.145240
ROW 2	-.277954E-02	.528988E-03	.843229E-02	-.419014E-02	-.125168E-02	-.344323E-02	.105968E-01
ROW 3	-.187181E-01	.356233E-02	.567851E-01	-.282175E-01	-.842913E-02	-.231876E-01	.713613E-01
ROW 4	-.102047E-01	.194211E-02	.309581E-01	-.153836E-01	-.459540E-02	-.126414E-01	.389048E-01
ROW 5	-.639403E-02	.121688E-02	.193976E-01	-.963898E-02	-.287936E-02	-.792079E-02	.243768E-01

	8	9
ROW 1	.675410E-01	-.868201E-02
ROW 2	-.492783E-02	.633445E-03
ROW 3	-.331852E-01	.426578E-02
ROW 4	-.180919E-01	.232562E-02
ROW 5	-.113360E-01	.145717E-02

Ordered Logit Model: Industry 7 - Food Products

Dependent Variable: Substitution of own production for imported products (19)

Maximum Likelihood Estimates	
Log-Likelihood..............	-75.263
Restricted (Slopes=0) Log-L.	-83.997
Chi-Squared (9)............	17.467
Significance Level..........	.41880E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	37.	.54412	4	3.	.04412			
1	16.	.23529						
2	7.	.10294						
3	5.	.07353						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-3.0704	2.037	-1.507	.13172		
X12	.49477E-01	.1097	.451	.65197	2.4706	2.5886
X9	.17069	.2384	.716	.47403	2.9118	1.1556
X10	.34790	.2354	1.478	.13945	1.8235	1.1963
X29	.61541E-01	.2000	.308	.75830	4.0000	1.5161
X40	.11967E-01	.2675	.045	.96432	4.2206	1.2678
X44	.10060	.2824	.356	.72167	4.5588	1.3755
X47	-.35725	.2248	-1.590	.11194	3.4853	1.4194
X48	.34597	.2618	1.321	.18640	3.9118	1.6367
X53	.24644	.2214	1.113	.26565	3.0294	1.4244
MU(1)	1.3625	.3585	3.800	.00014		
MU(2)	2.2661	.4466	5.074	.00000		
MU(3)	3.4240	.7130	4.802	.00000		

Predicted Probablities:[a]

	1
ROW 1	.551499
ROW 2	.276171
ROW 3	.945439E-01
ROW 4	.519732E-01
ROW 5	.258122E-01

a. No firm in the sample reported the dependent variable with value 6, what made impossible estimations for this level.

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.122380E-01	-.422205E-01	-.860518E-01	-.152221E-01	-.296011E-02	-.248820E-01	.883654E-01
ROW 2	.518103E-02	.178743E-01	.364304E-01	.644434E-02	.125318E-02	.105339E-01	-.374099E-01
ROW 3	.350777E-02	.121016E-01	.246649E-01	.436309E-02	.848453E-03	.713191E-02	-.253281E-01
ROW 4	.230508E-02	.795239E-02	.162082E-01	.286714E-02	.557548E-03	.468663E-02	-.166440E-01
ROW 5	.124415E-02	.429223E-02	.874821E-02	.154751E-02	.300931E-03	.252956E-02	-.898342E-02

	8	9
ROW 1	-.855750E-01	-.609556E-01
ROW 2	.362286E-01	.258059E-01
ROW 3	.245283E-01	.174717E-01
ROW 4	.161184E-01	.114812E-01
ROW 5	.869975E-02	.619688E-02

Ordered Logit Model: Industry 7 - Food Products (cont.)

Dependent Variable: Rationalization of production lines (16)

Maximum Likelihood Estimates	
Log-Likelihood..............	-106.70
Restricted (Slopes=0) Log-L.	-113.44
Chi-Squared (9)............	13.479
Significance Level..........	.14208

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	4.	.05797	4	16.	.23188			
1	5.	.07246	5	11.	.15942			
2	11.	.15942						
3	22.	.31884						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-.65967	1.577	-.418	.67565		
X12	.45805E-01	.9495E-01	.482	.62952	2.4928	2.5760
X9	.13491	.2054	.657	.51124	2.9275	1.1545
X10	.25483	.2199	1.159	.24661	1.8261	1.1876
X29	-.12144	.1946	-.624	.53255	4.0000	1.5049
X40	.54051E-01	.2323	.233	.81599	4.2174	1.2587
X44	.66154E-01	.1872	.353	.72377	4.5652	1.3664
X47	.17433	.1977	.882	.37799	3.4638	1.4202
X48	.32059	.1725	1.859	.06303	3.9275	1.6299
X53	.28132	.2177	1.292	.19635	3.0580	1.4337
MU(1)	1.0019	.4916	2.038	.04155		
MU(2)	2.1824	.6153	3.547	.00039		
MU(3)	3.7098	.7288	5.090	.00000		
MU(4)	4.9821	.7941	6.274	.00000		

Predicted Probablities:

	1
ROW 1	.438469E-01
ROW 2	.671776E-01
ROW 3	.178063
ROW 4	.362854
ROW 5	.217934
ROW 6	.130124

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.192034E-02	-.565592E-02	-.106837E-01	.509141E-02	-.226607E-02	-.277346E-02	-.730866E-02
ROW 2	-.260052E-02	-.765922E-02	-.144678E-01	.689477E-02	-.306870E-02	-.375581E-02	-.989736E-02
ROW 3	-.489278E-02	-.144106E-01	-.272207E-01	.129723E-01	-.577365E-02	-.706643E-02	-.186215E-01
ROW 4	-.980124E-03	-.288673E-02	-.545286E-02	.259861E-02	-.115658E-02	-.141555E-02	-.373028E-02
ROW 5	.520902E-02	.153420E-01	.289801E-01	-.138107E-01	.614682E-02	.752316E-02	.198251E-01
ROW 6	.518474E-02	.152705E-01	.288450E-01	-.137463E-01	.611818E-02	.748810E-02	.197327E-01

	8	9
ROW 1	-.134404E-01	-.117941E-01
ROW 2	-.182009E-01	-.159715E-01
ROW 3	-.342444E-01	-.300499E-01
ROW 4	-.685985E-02	-.601961E-02
ROW 5	.364577E-01	.319922E-01
ROW 6	.362878E-01	.318431E-01

Ordered Logit Model: Industry 7 - Food Products (cont.)

Dependent Variable: Purchase of foreign technology/Products licensing (24)

Maximum Likelihood Estimates

Log-Likelihood.............	-99.835
Restricted (Slopes=0) Log-L.	-110.73
Chi-Squared (9)...........	21.789
Significance Level..........	.95727E-02

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	20.	.29412	4	13.	.19118			
1	12.	.17647	5	1.	.01471			
2	9.	.13235						
3	13.	.19118						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-2.6332	1.676	-1.571	.11618		
X12	.13389	.9889E-01	1.354	.17575	2.4706	2.5886
X9	.18022	.2213	.814	.41545	2.9118	1.1556
X10	-.49833E-01	.2330	-.214	.83062	1.8235	1.1963
X29	-.83611E-02	.1768	-.047	.96228	4.0000	1.5161
X40	.14662E-01	.2791	.053	.95810	4.2206	1.2678
X44	-.75325E-01	.2062	-.365	.71491	4.5588	1.3755
X47	.55900E-01	.1971	.284	.77669	3.4853	1.4194
X48	.54679	.2065	2.648	.00810	3.9118	1.6367
X53	.33677	.1869	1.802	.07161	3.0294	1.4244
MU(1)	.95521	.2633	3.628	.00029		
MU(2)	1.6553	.3277	5.051	.00000		
MU(3)	2.7882	.4308	6.472	.00000		
MU(4)	5.8812	1.268	4.637	.00000		

Predicted Probablities:

	1
ROW 1	.236766
ROW 2	.209619
ROW 3	.172492
ROW 4	.215599
ROW 5	.156605
ROW 6	.891777E-02

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.241953E-01	-.325664E-01	.900519E-02	.151092E-02	-.264957E-02	.136118E-01	-.101015E-01
ROW 2	-.889276E-02	-.119695E-01	.330977E-02	.555324E-03	-.973824E-03	.500289E-02	-.371272E-02
ROW 3	.150729E-02	.202878E-02	-.560993E-03	-.941252E-04	.165059E-03	-.847970E-03	.629292E-03
ROW 4	.130870E-01	.176148E-01	-.487080E-02	-.817238E-03	.143312E-02	-.736246E-02	.546380E-02
ROW 5	.173105E-01	.232995E-01	-.644273E-02	-.108098E-02	.189563E-02	-.973852E-02	.722711E-02
ROW 6	.118337E-02	.159279E-02	-.440435E-03	-.738975E-04	.129588E-03	-.665740E-03	.494056E-03

	8	9
ROW 1	-.988098E-01	-.608569E-01
ROW 2	-.363166E-01	-.223674E-01
ROW 3	.615552E-02	.379119E-02
ROW 4	.534451E-01	.329168E-01
ROW 5	.706932E-01	.435399E-01
ROW 6	.483269E-02	.297645E-02

Ordered Logit Model: Industry 7 - Food Products (cont.)

Dependent Variable: Association with multinational enterprises (21)

Maximum Likelihood Estimates	
Log-Likelihood.............	-103.87
Restricted (Slopes=0) Log-L.	-113.90
Chi-Squared (9)............	20.060
Significance Level..........	.17546E-01

Cell Frequencies for Outcomes

Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.	Cell	Count	Rel.Freq.
0	21.	.30435	4	11.	.15942			
1	6.	.08696	5	3.	.04348			
2	14.	.20290						
3	14.	.20290						

Logistic probability model

Variable	Coefficient	Std. Error	t-ratio	Prob|t|≥x	Mean of X	Std.Dev.of X
Constant	-3.3798	1.623	-2.082	.03734		
X12	.17986	.9221E-01	1.951	.05111	2.4928	2.5760
X9	.99668E-01	.2089	.477	.63331	2.9275	1.1545
X10	.13116	.2260	.580	.56170	1.8261	1.1876
X29	-.26695E-01	.2038	-.131	.89577	4.0000	1.5049
X40	-.61075E-01	.2508	-.243	.80764	4.2174	1.2587
X44	.55359E-01	.2163	.256	.79798	4.5652	1.3664
X47	.18925	.1921	.985	.32450	3.4638	1.4202
X48	.38138	.1872	2.037	.04165	3.9275	1.6299
X53	.45191	.1712	2.640	.00829	3.0580	1.4337
MU(1)	.47741	.1928	2.476	.01327		
MU(2)	1.4547	.3057	4.758	.00000		
MU(3)	2.6215	.4691	5.588	.00000		
MU(4)	4.5675	.7075	6.455	.00000		

Predicted Probablities:

	1
ROW 1	.264333
ROW 2	.102423
ROW 3	.239396
ROW 4	.225575
ROW 5	.140185
ROW 6	.280886E-01

Matrix of Partial Effects:

	1	2	3	4	5	6	7
ROW 1	-.349750E-01	-.193816E-01	-.255053E-01	.519110E-02	.118766E-01	-.107652E-01	-.368023E-01
ROW 2	-.679586E-02	-.376597E-02	-.495584E-02	.100866E-02	.230770E-02	-.209174E-02	-.715091E-02
ROW 3	-.116654E-02	-.646447E-03	-.850694E-03	.173142E-03	.396129E-03	-.359057E-03	-.122749E-02
ROW 4	.177651E-01	.984466E-02	.129551E-01	-.263676E-02	-.603260E-02	.546804E-02	.186933E-01
ROW 5	.202622E-01	.112284E-01	.147761E-01	-.300739E-02	-.688055E-02	.623664E-02	.213209E-01
ROW 6	.491000E-02	.272091E-02	.358059E-02	-.728759E-03	-.166731E-02	.151128E-02	.516653E-02

	8	9
	-.741645E-01	-.878784E-01
	-.144106E-01	-.170753E-01
	-.247365E-02	-.293106E-02
	.376710E-01	.446368E-01
	.429661E-01	.509111E-01
	.104117E-01	.123369E-01

VITA

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CITIZENSHIP Brazilian

EDUCATION
Ph.D., 1996, University of Illinois.
M.S., 1989, University of Illinois.
B.Ec., 1984, Universidade de São Paulo.
B.Adm., 1984, Escola de Administração de Emprêsas de São Paulo.

PH. D. FIELDS Macroeconomics, International Economics, and Economic Development

DISSERTATION TITLE "The Opening of the Brazilian Economy and the State of its Firms and Industries"

TEACHING AND PROFESSIONAL EXPERIENCE

1993- : Country Economist, Inter-American Development Bank.

1992: Instructor, The Catholic University of America, Washington, D.C.: Macroeconomics, Economic Development and International Economics.

1987-1991: Teaching Assistant, University of Illinois.

1988: Summer Intern, **The World Bank**; Latin America - Brazil Department. Wrote an internal bank document analyzing debt convertion mechanisms and the absorptive capacity of the Brazilian equity markets.

1984-1986: Economist, Board of Economic and Financial Advisory Staff of Serfina S.A., the holding company of **Bunge & Born Corporation**, São Paulo, Brazil. Produced monthly reports and semi-annual macroeconometric forecasts for eight developed and five developing countries; developed long run econometric growth model used by the corporation for its investment decisions; supervisor of Uruguay's regional office of the Economic and Financial Advisory Staff; authored special studies.

1983-1984: Research Assistant, International Economics, Centro Brasileiro de Análise e Planejamento (**CEBRAP**), São Paulo, Brazil. Worked on the project "The World Economy in Brazil the World Economy".

1982-1983: Research Assistant, Labor Economics, Universidade de São Paulo. Project: "Labor Union Bargaining in the States of São Paulo, Rio de Janeiro, and Minas Geraes".
1981: Research Assistant, Universidade de São Paulo. Study: "Living and Working Conditions and their Repercussions on the Mental Health of Industrial Workers in Cubatão".
1979: Research Assistant, Escola de Administração de Emprêsas de São Paulo. Project "The Constitution of the Cultural Industry in the Brazilian Press".

HONORS AND SCHOLARSHIPS

1988-1991: Scholarship from Conselho Nacional de Desenvolvimento Científico e Tecnológico (**CNPq** - Brazil).
1988: Center for Latin America and Caribbean Studies Field Research Grant (**CLACS**), University of Illinois.
1987: **Fullbright Foundation Fellowship** for Graduate Studies Abroad.

PUBLICATIONS

The Debt-Equity Conversion Mechanism and the Absorptive Capacity of the Brazilian Stock Markets, University of Illinois, November 1991. (unpublished)
The Equity Market and the Debt Conversion Mechanisms into Domestic Equity in Brazil, The World Bank, Washington, D.C., September 1988. (internal document)
A Comparative Study of Social Security Systems in Western Countries, Serfina S.A., São Paulo, October 1986.
The U.S.S.R. Economy: Recent Developments and Future Trends, Serfina S.A., São Paulo, May 1986.
Long Run Scenarios of the World Economy, Serfina S.A., São Paulo, December 1985 (co-authors Martin Laphitzondo and Eduardo Bon Angelo).
World Economic and Political Review: From the Sixties to Present, Serfina S.A., São Paulo, May 1985 (responsible for the economic part of the study).

LANGUAGES

Fluent in English, French, Portuguese, and Spanish